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ABSTRACT

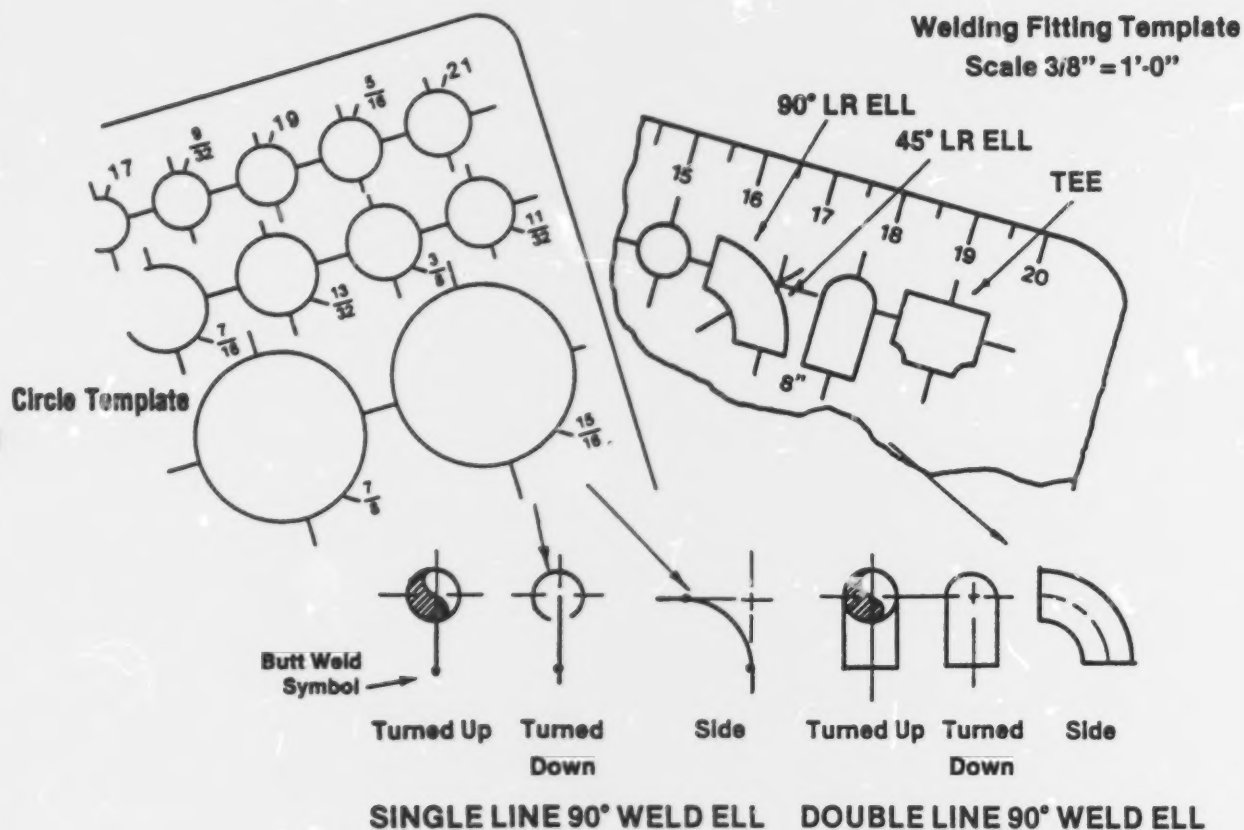
This module, 1 of 10 in the Drafting curriculum guide developed in Missouri, contains 7 units of study that include some or all of the following components: performance objectives, lesson plans, information sheets, transparency masters, handouts, assignment sheets, job sheets, a unit test, and answers to the unit test. Special instructions on using audiovisual aids, supplies, and equipment are included in notes to the instructor near the beginning of each unit. All units are competency based and cross-referenced to a competency profile at the beginning of the module. The units cover the following topics: (1) introduction to architectural drawings; (2) introduction to residential design; (3) dimensioning architectural drawings; (4) electrical drawings; (5) introduction to pipe drawings; (6) introduction to structural steel drawings; and (7) introduction to surveying (civil) drawings. (KC)

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7

INTRODUCTION TO DRAFTING FIELDS

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DRAFTING

Module 7: Introduction to Drafting Fields

Instructional Materials Laboratory
8 London Hall
University of Missouri-Columbia
Columbia, MO 65211

1992

Instructor's Guide
Catalog N. 70-4007-I

FOREWORD

Once again, we are indebted to the teachers and administrators who provided their time, effort, and professionalism to develop curriculum guides for trade, technical, and industrial education programs. This drafting guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation, and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, assignments sheets, and test items are keyed to specific competencies. A cross-reference table has been included to quickly identify the parts of the curriculum that relate to specific competencies.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future drafting curriculum modifications will begin with this guide. The drafting field is undergoing constant and considerable change. We will evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Carrie Haner, supervisor
Industrial Education
Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
Industrial Education
Department of Elementary and Secondary Education

ACKNOWLEDGEMENTS

This drafting guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the drafting competency profile developed by industry and education professionals in the state.

When searching for current drafting materials to adopt or use in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these drafting materials.

Special appreciation is given to the writers for their self-motivation, reliability, and technical expertise.

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Support and contributions of IML staff members were instrumental to this module's development.

Harley Schlichting, director
Amon Herd, associate director
Phyllis Miller and Dan Stapleton, assistant directors
Veronica Feilner, editor

Technical assistance was provided by the Academic Support Center, University of Missouri-Columbia.

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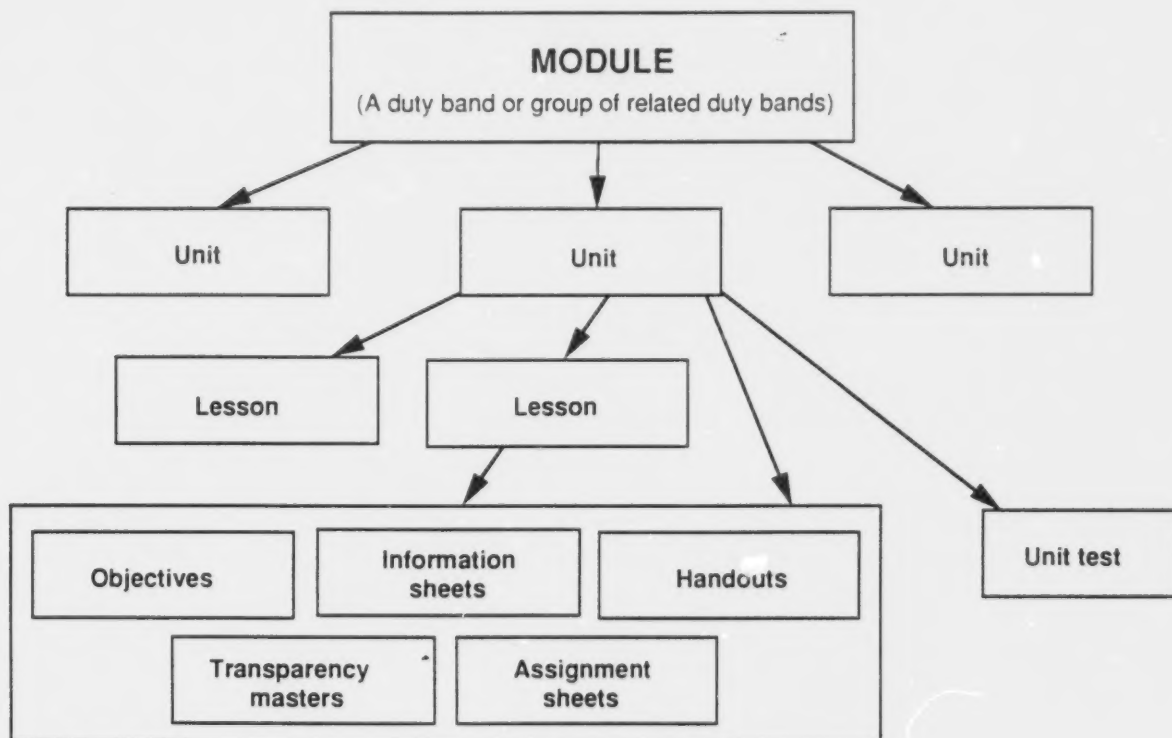
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HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Drafting guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc., are included in the "Notes to the Instructor" section near the beginning of each unit.



Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

- 3 = **Mastery** - can work independently with no supervision
- 2 = **Requires supervision** - can perform job completely with limited supervision
- 1 = **Not mastered** - requires instruction and close supervision
- .N = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Objectives and other components of the module (transparencies, handouts, and assignment sheets) are numbered consecutively throughout each unit. By looking at the cross-reference table, the instructor can quickly determine what test questions or assignment sheets a student needs to be evaluated on for a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives that state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The "Table of Contents" lists lesson titles and the transparency masters, handouts, and assignment sheets in each lesson. The "Reference Section" lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc., are included in the "Notes to the Instructor" section.

Information sheets (color-coded green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage, while **WARNING** statements recommend procedures to avoid bodily injury. Handouts and transparency masters are noted in the information sheets for instructional use.

Transparency masters (color-coded white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary, and they direct students to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion.

Handouts (color-coded white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (color-coded tan)

Assignment sheets provide students with paper-and-pencil activities that give students the opportunity to make practical application of the knowledge presented in the information sheets. The answers to the assignment sheets (color-coded pink) have been provided to assist the instructor in evaluating student performances. Many of the assignment sheets must be evaluated to the satisfaction of the instructor.

Unit test (color-coded yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), using Scantron sheets for computer-recording of test answers. If additional objectives have been added, additional test items will also need to be added.

It is recommended that the test be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets and assignment sheets lesson by lesson.
5. Give students unit test and assignment sheets.

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Take unit test and do assignment sheet(s).

Drafting

Module: Introduction to Drafting Fields

Cross-Reference Table of Instructional Materials

Competency	Unit	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Test Item	Notes
K-1	I	1.1-1.8	1.1-1.8		1.1-1.6	1-28	
K-2	I II III IV	 2.1-2.11 3.1-3.6 4.1-4.11	 1.1-1.8 2.1-2.10 3.1-3.4 4.1-4.11		 1.1-1.6 2.1-2.7 3.1, 3.2 4.1-4.5	 1-45 1-10, 21-51, 62, 63 1-84	
K-4	III	3.3, 3.7-3.90	3.1, 3.5-3.7		3.3	1-32, 52-63	
L-1	IV	4.1-4.11	4.1-4.11		4.1-4.5	1-84	
L-2	IV	4.1-4.11	4.1-4.11		4.1-4.5	1-84	
M-1	V	5.1-5.21	5.1-5.23		5.1-5.7	1-171, 209	
M-2	V	5.22-5.41	5.24-5.26		5.8	172-208, 210-220	
N-1	VI	6.1-6.5	6.1			1-48	
N-2	VI	6.6-6.9	6.2-6.4		6.1	49-65	
N-3	VI	6.10-6.12	6.5-6.7		6.2	66-72	
P-1	VII	7.1-7.17			7.1, 7.2	1-118	
P-2	VII	7.18-7.27	7.1-7.3		7.3	119-171	
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MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT I: INTRODUCTION TO ARCHITECTURAL DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to arrange in order a set of working drawings and identify plan and elevation symbols of doors and windows. The student should also be able to sketch and draw floor plans and elevations. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

- 1.1 Match common U.S. scales used with the correct parts of a set of working drawings.
- 1.2 Identify plan symbols of various doors and windows.
- 1.3 Identify plan symbols of bathroom and kitchen fixtures and built-in components.
- 1.4 Identify elevation symbols of various doors and windows.
- 1.5 Match exterior materials with the correct symbols.
- 1.6 Select true statements concerning factors to consider when drawing elevations.
- 1.7 Arrange in order the steps in projecting elevations.
- 1.8 Demonstrate the ability to:
 - a. Sketch a floor plan of your house. (AS 1.1)
 - b. Draw a floor plan from a preliminary sketch. (AS 1.2)
 - c. Sketch different roofs on an elevation. (AS 1.3)
 - d. Resketch an elevation to eliminate the inconsistent use of materials. (AS 1.4)
 - e. Sketch two different elevations of the same floor plan. (AS 1.5)
 - f. Draw a front and side elevation. (AS 1.6)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT I: INTRODUCTION TO ARCHITECTURAL DRAWINGS

CONTENTS OF THIS UNIT

- A. Objective sheets
- B. References
- C. Notes to the instructor
- D. Lesson plan
 - 1. **Lesson 1: Architectural Drawings** 5
 - a. Information outline
 - b. Transparency masters
 - TM 1.1: Door Plan Symbols
 - TM 1.2: Window Plan Symbols
 - TM 1.3: Plan Symbols
 - TM 1.4: Door Elevation Symbols
 - TM 1.5: Window Elevation Symbols
 - TM 1.6: Ways Different Roofs Affect Elevation Appearance
 - TM 1.7: Factors Which Affect Elevation Appearance
 - TM 1.8: Projecting an Elevation
 - c. Assignment sheets
 - AS 1.1: Sketch a Floor Plan of Your House
 - AS 1.2: Draw a Floor Plan from a Preliminary Sketch
 - AS 1.3: Sketch Different Roofs on an Elevation
 - AS 1.4: Resketch an Elevation to Eliminate the Inconsistent Use of Materials
 - AS 1.5: Sketch Two Different Elevations of the Same Floor Plan
 - AS 1.6: Draw a Front and Side Elevation
 - d. Answers to assignment sheets
- E. Unit test
- F. Answers to unit test

REFERENCES

- A. Davis, Ronald and Bruce Yancey. Architectural Drafting. Stillwater, OK: Mid-America Vocational Curriculum Consortium, Inc., 1982.
- B. Hepler, Donald E. and Paul I. Wallach. Architecture Drafting and Design. St. Louis, MO: Gregg Division/McGraw-Hill Book Co., 1977.

- C. Kicklighter, Clois E. Architecture: Residential Drawing and Design. South Holland, IL: Goodheart-Willcox Co., Inc., 1973.
- D. Spence, William P. Architecture Design - Engineering - Drawing. Bloomington, IL: McKnight Publishing Co., 1979.

NOTES TO THE INSTRUCTOR

- A. Suggested approaches to teaching this unit
 - 1. Provide samples of residential and commercial working drawings.
 - 2. Discuss the good and bad features of the sample drawings, especially in the floor plan and elevations.
 - 3. Discuss which roofs are usually used on different styles of houses and buildings.
 - 4. Provide examples of roof styles other than the basic styles. Try to include Gambrel, Mansard, and others which are used in your area.
 - 5. Provide Sweet's Catalog File or manufacturer's product catalogs for use in AS 1.5.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT I: INTRODUCTION TO ARCHITECTURAL DRAWINGS

LESSON 1: ARCHITECTURAL DRAWINGS

I. Common scales used on a set of working drawings

	U.S.	ISO METRIC (mm)
A. Plot plan	1" = 20' or 40'	1:100, 1:200 or 1:500
B. Foundation plan	1/8" or 1/4" = 1'-0"	1:100 or 1:50
C. Floor plan	1/8" or 1/4" = 1'-0"	1:100 or 1:50
D. Elevations	1/8" or 1/4" = 1'-0"	1:100 or 1:50
E. Construction details	3/4" to 1 1/2" = 1'-0"	1:20 or 1:10
F. Wall section details	3/4" to 1 1/2" = 1'-0"	1:20 or 1:10
G. Interior elevations	3/8" to 1/2" = 1'-0"	1:50 or 1:25

II. Plan symbols of doors and windows

A. Doors (TM 1.1)

1. Interior doors

- a. Flush or panel
- b. French
- c. Sliding
- d. Pocket
- e. Bi-fold
- f. Double action
- g. Accordion
- h. Archway or cased opening

2. Exterior doors

- a. Hinged
- b. French

c. Sliding

B. Windows (TM 1.2)

1. Double hung
2. Casement
3. Sliding
4. Awning
5. Hopper
6. Fixed picture

NOTE: Special windows are indicated by a note.

III. Plan symbols of bathroom and kitchen fixtures and built-in components (TM 1.3)

A. Bathroom Fixtures

1. Water closet
2. Wall-hung water closet
3. Free-standing lavatory
4. Wall-hung lavatory
5. Bathtub
6. Shower

B. Kitchen and laundry fixtures

1. Sink
2. Refrigerator
3. Cooktop
4. Free-standing range
5. Oven
6. Dishwasher
7. Washer
8. Dryer
9. Microwave

10. Trash compactor

C. Built-in components

1. Fireplace

2. Medicine cabinet

3. Closet

4. Stairs

5. Bookcases

6. Cabinets

IV. Elevation symbols of doors and windows

A. Doors (TM 1.4)

1. Flush

2. Panel

3. French

4. Sliding

5. Pocket

6. Bi-fold

7. Double action

8. Accordion

B. Windows (TM 1.5)

1. Double hung

2. Casement

3. Sliding

4. Awning

5. Hopper

6. Fixed picture

V. Exterior material symbols

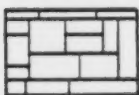
A. Brick



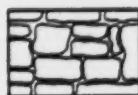
B. Concrete block



C. Cut stone



D. Rock



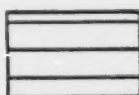
E. Concrete and cement



F. Wood shingle



G. Horizontal wood siding



H. Vertical wood siding



I. Board and batten



J. Glass



K. Stucco



VI. Factors to consider when drawing elevations (TMs 1.6 and 1.7)

- A. Use formal or informal balance.

NOTE: Formal balance is symmetrical—left side is identical to right side. This type of balance is used in traditional architecture. Informal balance is asymmetrical and is widely used in contemporary architecture.

- B. Every elevation should have some point of emphasis.
- C. Use no more than two types of exterior sidings.
- D. Do not mix types of masonry (stone and brick) or vertical and horizontal siding.

NOTE: This is only a general rule.

- E. The basic horizontal lines of an elevation are the ground line, eave line, and ridge line.
Example:

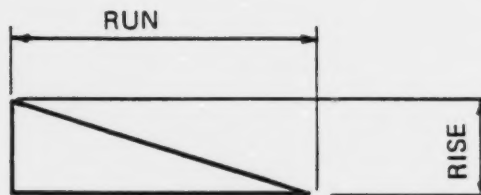


- F. Door and window lines should be related to other structural lines.
- G. Sufficient roof overhang is needed to afford protection from sun, rain, and snow.
- H. Type of roof greatly affects the appearance of an elevation.
- I. Slope of roof needs to be calculated in order to show the slant of a roof. Use the following formulas:

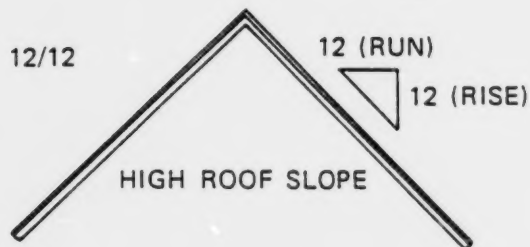
Formula: Rise = Vertical distance

Run = Horizontal distance

Slope = Rise/run



Examples:



VII. Steps in projecting elevations (TM 1.8)

- A. Project floor plan outline and door, window, and chimney locations; draw horizontal lines (bridge, eave, and ground).
- B. Lay out roof slope, add roof overhang, locate chimney (if used), and block in outline.
- C. Lay out door and window outlines, and draw building material divisions.
- D. Add details and siding symbols, draw vegetation, and add basement outline (if used).

DOOR PLAN SYMBOLS

Interior Doors



Flush or Panel (Shown 90°)



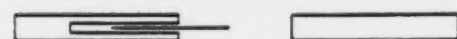
Flush or Panel (Shown 45°)



French



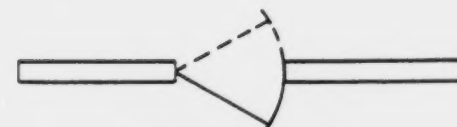
Sliding



Pocket



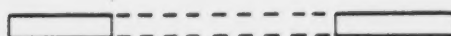
Bi-Fold



Double Action

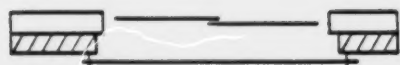


Accordion

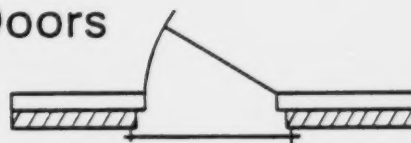


Archway or Cased Opening

Exterior Doors



Sliding (in Brick Veneer Wall)

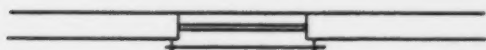


Hinged (In Brick Veneer Wall)



French

WINDOW PLAN SYMBOLS



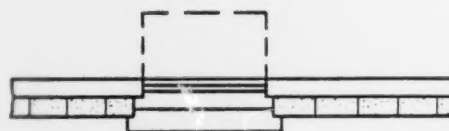
Double Hung (in Frame Wall)



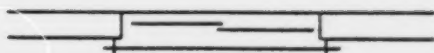
**Fixed with
Double Hung Side Lights**



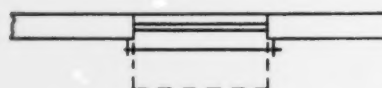
Double Casement



Hopper (in Cut Stone Veneer)



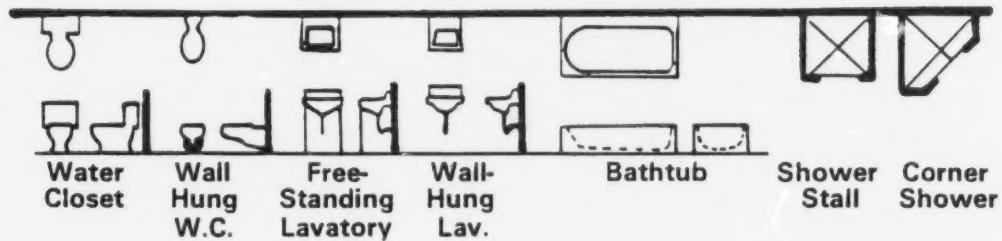
Sliding



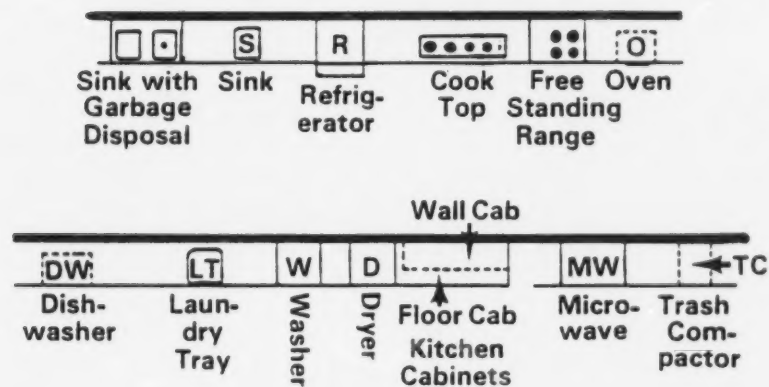
Awning

PLAN SYMBOLS

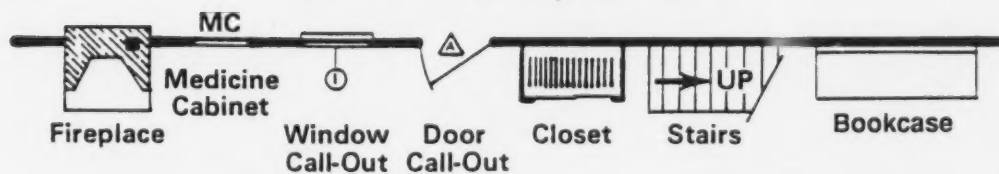
Bathroom Fixtures



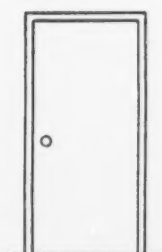
Kitchen and Laundry Fixtures



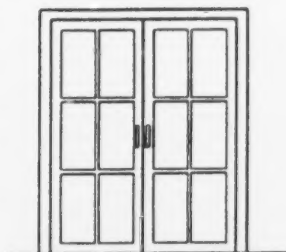
Built-In Components



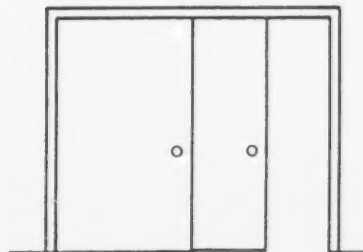
DOOR ELEVATION SYMBOLS



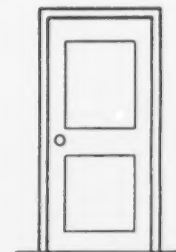
Flush



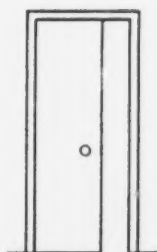
French



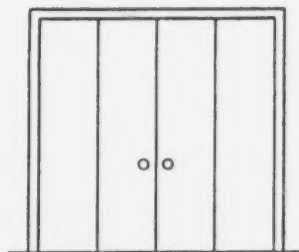
Sliding



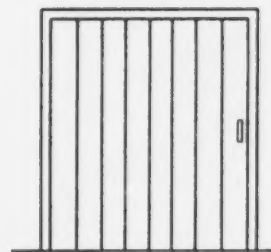
Panel



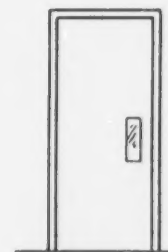
Pocket



Bi-Fold

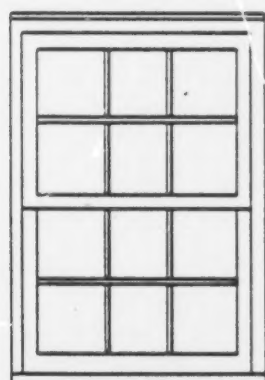


Accordion

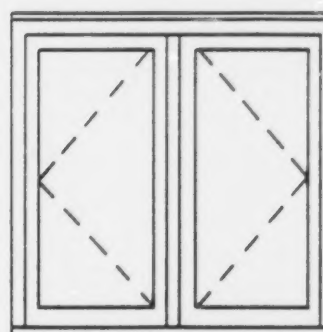


Double Action

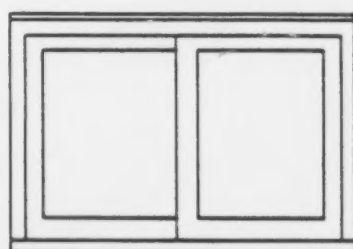
WINDOW ELEVATION SYMBOLS



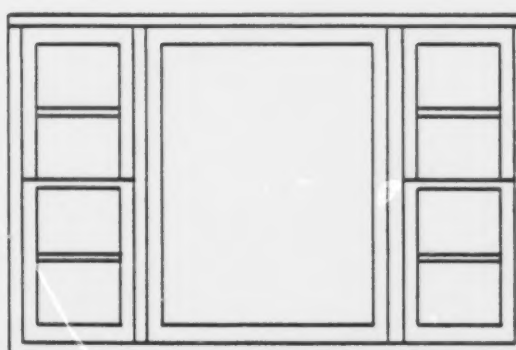
Double Hung



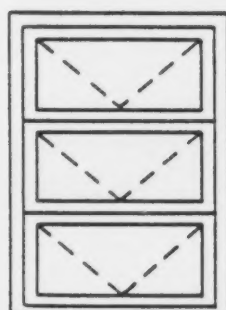
Double Casement



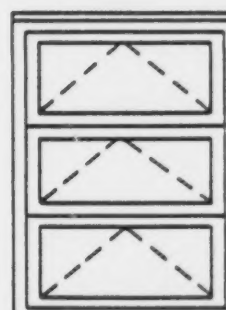
Sliding



Fixed with
Double Hung Side Lights

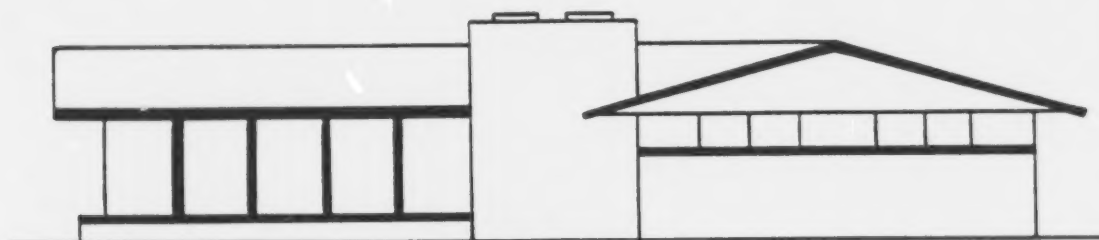


Hopper

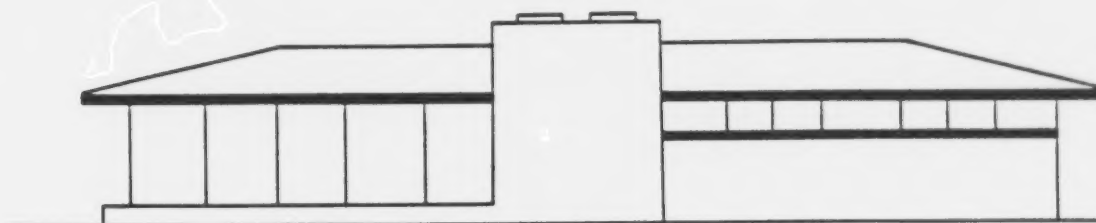


Awning

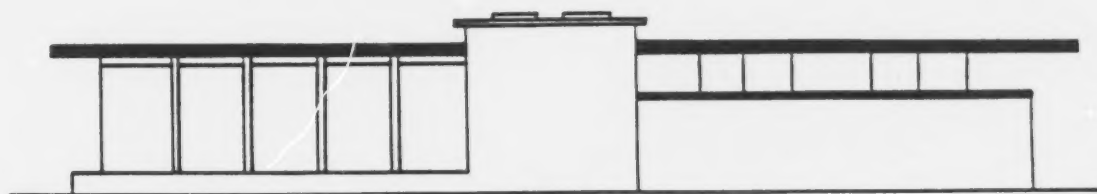
WAYS DIFFERENT ROOFS AFFECT ELEVATION APPEARANCE



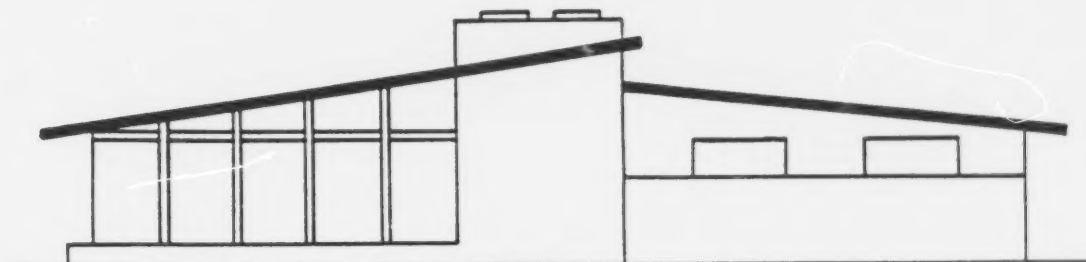
Gable



Hip



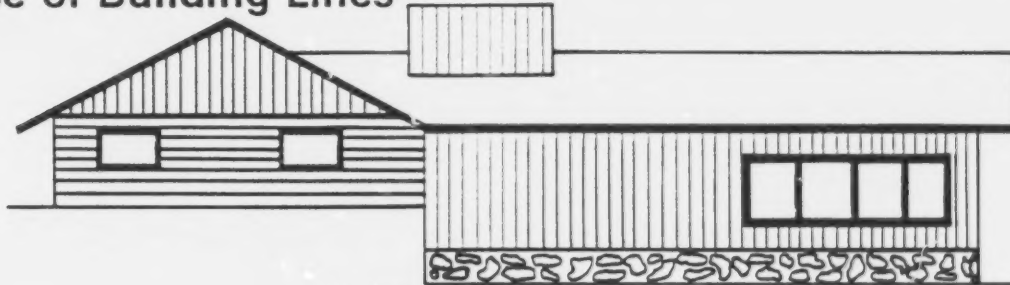
Flat



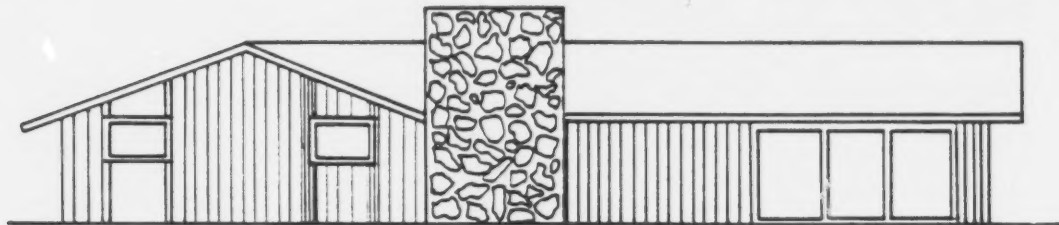
Shed

FACTORS WHICH AFFECT ELEVATION APPEARANCE

Use of Building Lines

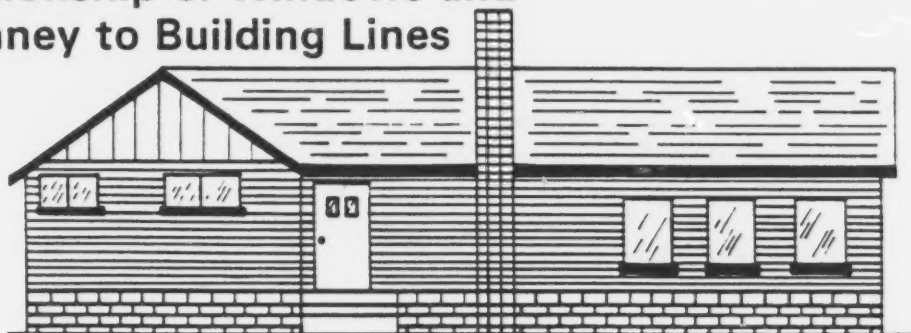


Inconsistent Lines

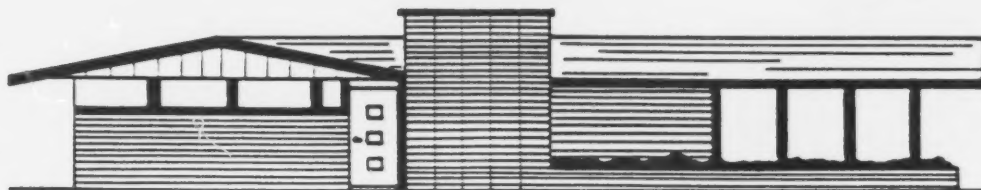


Consistent Lines

Relationship of Windows and Chimney to Building Lines

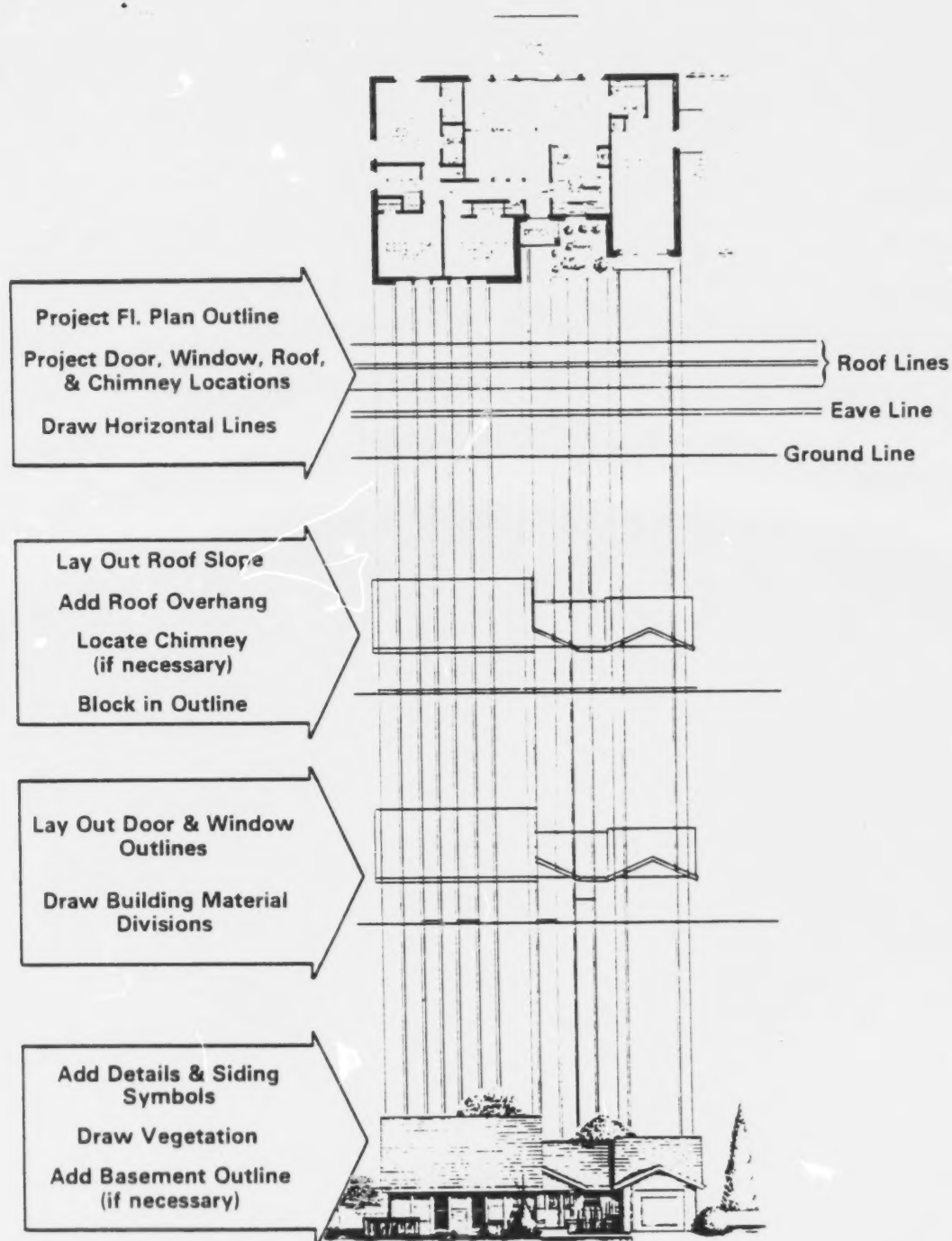


Unrelated



Related

PROJECTING AN ELEVATION



SKETCH A FLOOR PLAN OF YOUR HOUSE

Directions: Measure the rooms in your house. On grid paper sketch a floor plan of your house. Use the scale $1/4" = 1'-0"$ or $1/8" = 1'-0"$.

DRAW A FLOOR PLAN FROM A PRELIMINARY SKETCH

Directions: Draw a floor plan using the preliminary sketch you made for AS 1.1. Use the appropriate floor plan symbols covered in this unit.

SKETCH DIFFERENT ROOFS ON AN ELEVATION

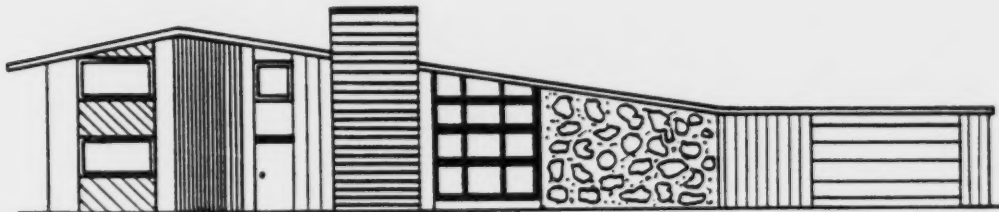
Directions: Since the type of roof greatly affects the appearance of an elevation, make four sketches of the following house and add one of the basic roof types to each sketch.

- A. Hip
- B. Shed
- C. Flat
- D. Gable



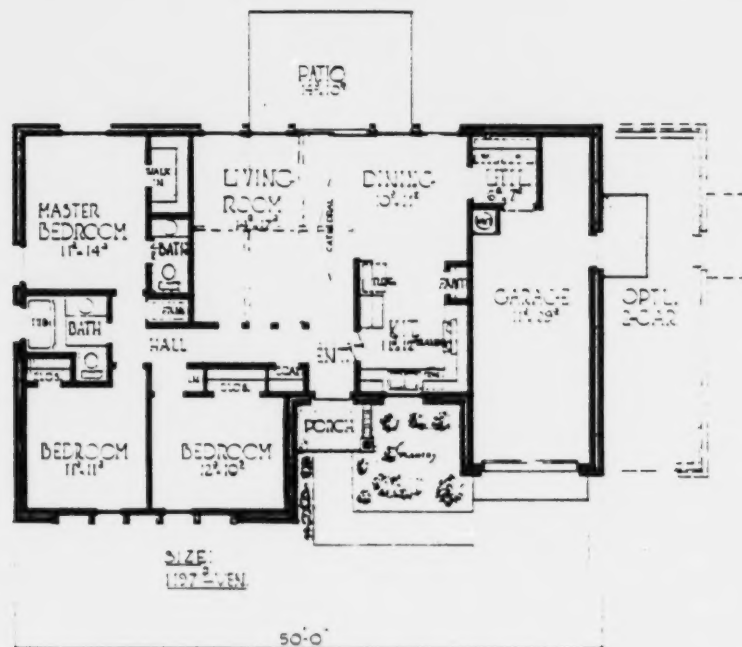
RESKETCH AN ELEVATION TO ELIMINATE THE INCONSISTENT USE OF MATERIAL

Directions: Too many materials are used on the following building. Sketch an elevation of this house and change the building materials to be consistent with the design.



SKETCH TWO DIFFERENT ELEVATIONS OF THE SAME FLOOR PLAN

Directions: Sketch two different elevations of the following floor plan. Different types of roofs or exterior material are easy ways to change the appearance of a house.



DRAW A FRONT AND SIDE ELEVATION

Directions: Draw a front and side elevation using the floor plan you drew in AS1.2.

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT I: INTRODUCTION TO ARCHITECTURAL DRAWINGS
ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS

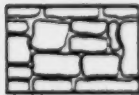
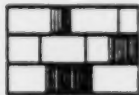
UNIT I: INTRODUCTION TO ARCHITECTURAL DRAWINGS

UNIT TEST

Match common U.S. scales on the right used with the correct parts of a set of working drawings.

- | | | | |
|--------|----------------------|----|------------------------|
| ___ 1. | Foundation plan | a. | 1" = 20' or 40' |
| ___ 2. | Construction details | b. | 1/8" or 1/4" = 1'-0" |
| ___ 3. | Plot plan | c. | 3/4" to 1 1/2" = 1'-0" |
| ___ 4. | Interior elevations | d. | 3/8" to 1/2" = 1'-0" |
| ___ 5. | Elevations | | |
| ___ 6. | Floor plan | | |
| ___ 7. | Wall section details | | |

Match the exterior materials on the right with the correct symbols.

- | | | | |
|---------|---|-----|------------------------|
| ___ 8. |  | a. | Glass |
| ___ 9. |  | b. | Rock |
| ___ 10. |  | c. | Horizontal wood siding |
| ___ 11. |  | d. | Wood shingle |
| ___ 12. |  | e. | Stucco |
| ___ 13. |  | ab. | Brick |
| ___ 14. |  | ac. | Concrete block |

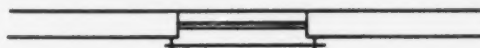
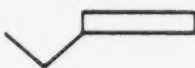
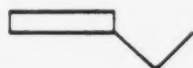
Select true statements concerning factors to consider when drawing elevations by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- ___ 15. Always use formal balance.
- ___ 16. Every elevation should have some point of emphasis.
- ___ 17. Use at least four types of exterior sidings for variety.
- ___ 18. The basic horizontal lines of an elevation are the vanishing lines and property lines.
- ___ 19. Sufficient roof overhang is needed to afford protection from sun, rain, and snow.
- ___ 20. Type of roof does not affect the appearance of an elevation.
- ___ 21. Slope of roof needs to be calculated in order to show the slant of a roof.

Arrange in order the steps in projecting elevations by placing the correct sequence letters in the appropriate blanks: a = 1 b = 2 c = 3 d = 4

- ___ 22. Lay out door and window outlines, and draw building material divisions.
- ___ 23. Add details and siding symbols, draw vegetation, and add basement outline (if used).
- ___ 24. Lay out roof slope, add roof overhang, locate chimney (if used), and block in outline.
- ___ 25. Project floor plan outline and door, window, and chimney locations; draw horizontal lines.

26. Identify plan symbols of the following doors and windows.



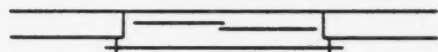
a. _____

b. _____



c. _____

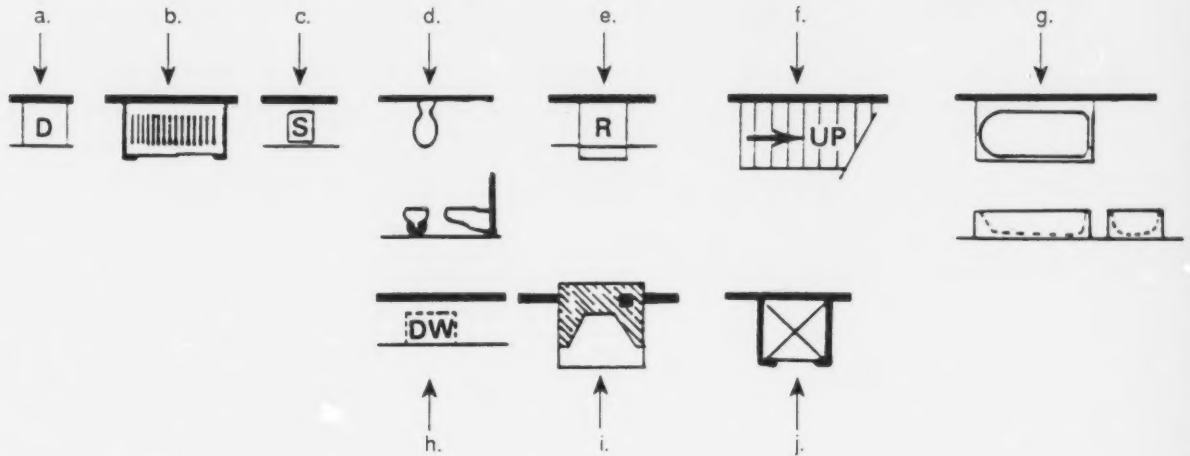
d. _____



e. _____

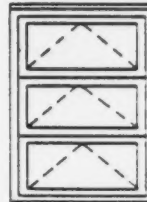
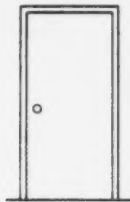
f. _____

27. Identify plan symbols of the following bathroom and kitchen fixtures and built-in components.

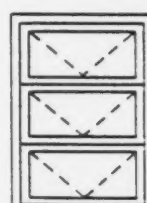
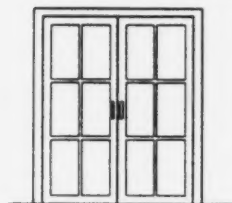


- | | |
|----------|----------|
| a. _____ | b. _____ |
| c. _____ | d. _____ |
| e. _____ | f. _____ |
| g. _____ | h. _____ |
| i. _____ | j. _____ |

28. Identify elevation symbols of the following doors and windows.



- | | |
|----------|----------|
| a. _____ | b. _____ |
|----------|----------|



- | | |
|----------|----------|
| c. _____ | d. _____ |
|----------|----------|

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT I: INTRODUCTION TO ARCHITECTURAL DRAWINGS

ANSWERS TO UNIT TEST

1. b (K-2, K-4)
2. c (K-2, K-4)
3. a (K-2, K-4)
4. d (K-2, K-4)
5. b (K-2, K-4)
6. b (K-2, K-4)
7. c (K-2, K-4)
8. ab (K-2)
9. e (K-2)
10. ac (K-2)
11. c (K-2)
12. b (K-2)
13. a (K-2)
14. d (K-2)
15. b (K-2)
16. a (K-2)
17. b (K-2)
18. b (K-2)
19. a (K-2)
20. b (K-2)
21. a (K-2)
22. c (K-2)
23. d (K-2)
24. b (K-2)
25. a (K-2)
26. (K-2)
 - a. Bi-fold door
 - b. Double hung window
 - c. Sliding door
 - d. Double action door
 - e. Pocket door
27. (K-2)
 - a. Dryer
 - b. Closet
 - c. Sink
 - d. Wall-hung water closet
 - e. Refrigerator
 - f. Stairs
 - g. Bathtub
 - h. Dishwasher
 - i. Fireplace
 - j. Shower
28. (K-2)
 - a. Flush door
 - b. Awning window
 - c. French door
 - d. Hopper window

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT II: INTRODUCTION TO RESIDENTIAL DESIGN

UNIT OBJECTIVE

After completion of this unit, the student should be able to plan the various areas of a house and develop a residential sketch. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

- 2.1 List five items needed from a client when planning a residence.
- 2.2 Select characteristics of a lot which can affect building design.
- 2.3 Distinguish between rooms located in basic areas of the house.
- 2.4 Match rooms in the living area with the correct characteristics.
- 2.5 Match rooms in the service area with the correct characteristics.
- 2.6 Complete a chart of characteristics of rooms in the sleeping area.
- 2.7 State the general rule to remember when planning the flow of traffic through a house.
- 2.8 Select true statements concerning factors to observe when planning the flow of traffic between rooms.
- 2.9 Match categories of storage facilities with the correct descriptions.
- 2.10 Sequence the steps for making a preliminary residential sketch.
- 2.11 Demonstrate the ability to:
 - a. Determine client needs. (AS 2.1)
 - b. Plan a kitchen. (AS 2.2)
 - c. Plan a sleeping area. (AS 2.3)
 - d. Plan a bathroom. (AS 2.4)
 - e. Plan traffic patterns. (AS 2.5)
 - f. Plan storage facilities. (AS 2.6)
 - g. Develop a preliminary residential sketch. (AS 2.7)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT II: INTRODUCTION TO RESIDENTIAL DESIGN

CONTENTS OF THIS UNIT

- A. Objective sheets
- B. References
- C. Notes to the instructor
- D. Lesson plan
 - 1. **Lesson 1: Residential Design** 51
 - a. Information outline
 - b. Transparency masters
 - TM 2.1: Types of Living Rooms
 - TM 2.2: Dining Room
 - TM 2.3: Kitchen Arrangements
 - TM 2.4: Kitchen
 - TM 2.5: Utility Room
 - TM 2.6: Bedroom
 - TM 2.7: Bathroom Clearances
 - TM 2.8: Bathroom Sizes
 - TM 2.9: Traffic Patterns
 - TM 2.10: Storage Areas
 - c. Assignment sheets
 - AS 2.1: Plan a Kitchen
 - AS 2.2: Plan a Sleeping Area
 - AS 2.3: Plan a Bathroom
 - AS 2.4: Plan Traffic Patterns
 - AS 2.5: Plan Storage Facilities
 - AS 2.6: Develop a Preliminary Residential Sketch
 - AS 2.7: Make a Scale Drawing of the Residential Sketch
 - d. Answers to assignment sheets
- E. Unit test
- F. Answers to unit test

REFERENCES

- A. Davis, Ronald and Bruce Yancey. Architectural Drafting. Stillwater, OK: Mid-America Vocational Curriculum Consortium, Inc., 1982.

- B. Hepler, Donald E. and Paul I. Wallach. Architecture Drafting and Design. St. Louis, MO: Gregg Division/McGraw-Hill Book Co., 1977.
- C. Goodban, William T. and Jack J. Hayslett. Architectural Drawing and Planning. St. Louis, MO: Gregg Division/McGraw-Hill Book Co., 1979.
- D. Hornung, William J. Architectural Drafting. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966.
- E. Spence, William P. Architecture Design - Engineering-Drawing. Bloomington, IL: McKnight Publishing Co., 1979.
- F. Kicklighter, Clois E. and Ronald J. Baird. Architecture Residential Drawing and Design. South Holland, IL: Goodheart-Willcox Co., Inc., 1973.
- G. Stegman, George K. and Harry J. Stegman. Architectural Drafting. Chicago, IL: American Technical Society, 1974.

NOTES TO THE INSTRUCTOR

- A. Suggested approaches to teaching this unit
 - 1. Take a field trip in your area to see different types of model home
 - 2. Have a residential contractor talk to class.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT II: INTRODUCTION TO RESIDENTIAL DESIGN

LESSON 1: RESIDENTIAL DESIGN

- I. Information needed from client when planning a residence
 - A. Financial ability of client

NOTE: Relate this to local square footage building costs.
 - B. What the client wants
 - C. Minimum requirements of the client
 - D. Client's preference in architectural style
 - E. Lot size and location
- II. Characteristics of a lot which can affect building design
 - A. Location of natural and man-made features

Examples: Natural--water, trees; man-made--existing structures, sidewalks
 - B. Relationship of front elevation and entries to the street
 - C. View
 - D. Prevailing winds
 - E. Direction of lot

NOTE: This affects the orientation of a structure.
 - F. Size of lot
 - G. Shape of lot
 - H. Slope of lot
 - I. Building restrictions
- III. Rooms located in basic areas of a house
 - A. Living
 - 1. Entrance
 - 2. Living room

3. Dining room
4. Recreation room
5. Family room
6. Den
7. Porch

NOTE: Instead of a porch, a patio or a Hawaiian porch [lanai] may be included.

B. Service

1. Kitchen
2. Laundry
3. Utility
4. Garage or carport
5. Workshop

C. Sleeping

1. Bedroom
2. Bathroom

IV. Rooms in the living area and characteristics (TMs 2.1 and 2.2)

<u>Room</u>	<u>Purpose</u>	<u>Minimum Sizes</u>	<u>Extra Features</u>	<u>Location</u>
Entrance	Area through which people enter the house	Room--6' x 6' Door--3'-0" x 6'-8"	Closet; weather resistant flooring	Main part of house, service area, or between indoor and outdoor living areas
Living Room	Primarily used for formal or informal relaxation and recreation; may be used for almost any purpose	Varies according to use and size of family	May include a fireplace; should have focal point such as picture window or fireplace	Adjacent to main entrance
Dining Room	Area used for formal or informal dining	Varies according to use and size of family; usually not less than 10' x 12'	Decor consistent with living room	Near the kitchen and usually near the living room
Recreation Room	Used as a play room or game room for recreational activities	Depends upon use and size of furnishings to be included	Should be easy to maintain; should include storage space	May be located in basement, attic, or main level of house, depending upon available space
Family Room	Used for family-centered activities such as TV, music, or table games	Depends upon use and size of furnishings to be included	Should be easy to maintain; should include storage space	Usually located near the kitchen; may be near living or dining rooms
Den	Use depends on family; usually for quiet activities such as work or study	Depends upon use and size of furnishings to be included Door--2'-8" x 6'-8"	May be designed to serve as a guest bedroom	Near both living and sleeping areas, if possible
Porch	Varies; may be used for entertaining, dining, or to provide shelter for the entrance	Room--6' x 8' Door--3'-0" x 6'-8"	Coverings and furnishings should be weather resistant	Outside, near entrance according to occupants' needs/uses

V. Rooms in the service area and characteristics (TMs 2.3, 2.4 and 2.5)

<u>Room</u>	<u>Purpose</u>	<u>Minimum Sizes</u>	<u>Extra Features</u>	<u>Location</u>
Kitchen	Wash, store, and cook food; may serve as dining or laundry	Depends upon use and style of kitchen	Storage and mixing area, preparation and cleaning area, and cooking area; adequate ventilation; doors should swing away from work area; sufficient utility outlets	Adjacent to dining room and outside entrance
Laundry	Wash, dry, and care for occupants' clothing and household articles	No minimum size, but ample work space must be provided	Storage for supplies; utility outlets to accommodate appliances	Near service entrance facilities; may be in sleeping area
Utility Room	May serve as laundry in addition to other areas such as storage, sewing, or food preservation	No minimum size; size depends upon use	Storage for supplies; utility outlets to accommodate appliances	Near service entrance and plumbing facilities
Garage or Carport	Provide shelter for one or more vehicles	Depends on size and number of vehicles; single--12' x 20', double--20' x 20'	Storage, driveway, fireproof wall between garage and living area	Attached, detached, or connected by a breezeway to the other service areas
Workshop	Depends upon occupant use, such as hobbies or work	Depends upon size or type of tools and use made of the area	Soundproofing and fire protection may be added; workbench; storage for supplies and tools; should be easy to clean and require low maintenance	Located near service area and away from sleeping area

VI. Characteristics of rooms in the sleeping area (TMs 2.6, 2.7 and 2.8)

<u>Room</u>	<u>Purpose</u>	<u>Minimum Sizes</u>	<u>Extra Features</u>	<u>Location</u>
Bedroom	Quiet activities such as sleeping, resting, or reading	Room--100 sq. ft. Door--2'-8" x 6'-8"	Closets; windows and/or ventilation	Quiet part of house
Bathroom	Personal hygiene; may provide other functions such as laundry or dressing	Room--5' x 8' Door--2'-0" x 6'-8"	Storage space; ventilation	Near bedrooms or near service area

NOTE: Door sizes will vary for wheel chair access.

- VII. General rule to remember when planning the flow of traffic through a house--People must be able to move from room to room and from one part of the house to another with a minimum of congestion and unnecessary steps.

NOTE: Rooms can be rendered useless by having a main traffic aisle directed through them.

- VIII. Factors to observe when planning the flow of traffic between rooms (TM 2.9)

- A. Plan for the heaviest flow of traffic to occur between the kitchen and dining areas, the bedrooms and bath, and the living and dining areas.
- B. Dining area should be next to the kitchen and easily accessible.
- C. It should be possible to enter the kitchen without crossing the dining area.
- D. Have kitchen adjacent to service entrance.

NOTE: An outside door is very desirable in a kitchen.

- E. Locate the garage or carport near the kitchen and have an entrance permitting easy access into it.
- F. Bedrooms should have easy access to a bath.
- G. Each bedroom should have access to a hall.

NOTE: It is poor design to have to go through one bedroom to reach another.

- H. Plan to be able to enter a house and go to the bedroom area or bath without crossing through the living area.

NOTE: This will provide privacy, but may not always be possible in every house plan.

- IX. Categories of storage facilities and descriptions (TM 2.10)

- A. Wardrobe closets--Shallow clothes closets built into the wall.

NOTE: The minimum inside depth is 24" clear. Doors should expose all parts of the closet for easy access.

- B. Walk-in closets--Closets which are large enough to walk into.

NOTE: The area needed for this type of closet is an area equal to the amount of space needed to hang clothes plus enough space to walk and turn. Only one door is needed.

- C. Wall closets--Shallow closets in the wall holding cupboards, shelves, and drawers.

NOTE: Wall closets are normally 18" deep, since this size provides access to all stored items without using an excessive amount of floor area. Swing out doors provide extra storage on the back of the door; however, space must be provided for the swing. For this reason, sliding doors are usually preferred.

- D. Chests and dressers--Free standing pieces of furniture used for storage

NOTE: The drafter may not have to design these items, but should remember to provide adequate space for their use.

- E. Room dividers--Free standing storage facilities which may be used to divide a large space into smaller areas

NOTE: Many room dividers include shelves and drawers that open from either side.

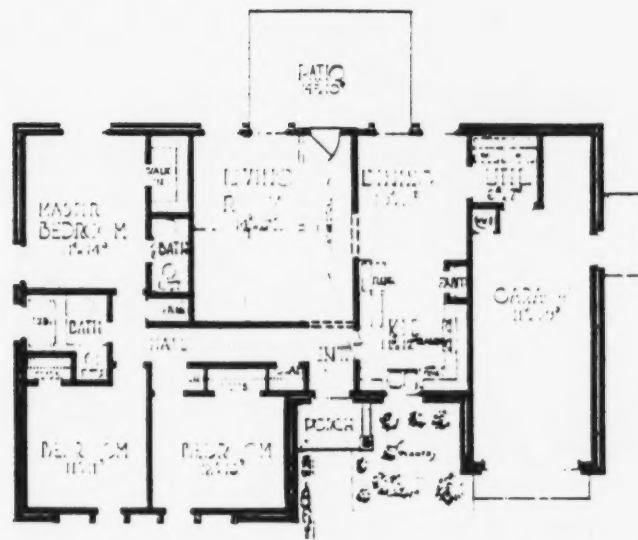
X. Steps for making a preliminary residential sketch

- A. Determine client needs
- B. Make a list of furniture needed
- C. Select an architectural style
- D. Determine sizes of furniture
- E. Make furniture templates
- F. Arrange furniture templates
- G. Determine room dimensions
- H. Combine rooms into areas
- I. Combine areas into floor plan
- J. Design outside by projecting elevations

TYPES OF LIVING ROOMS

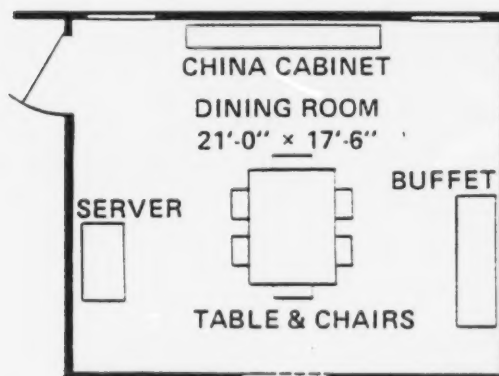


Open Plan

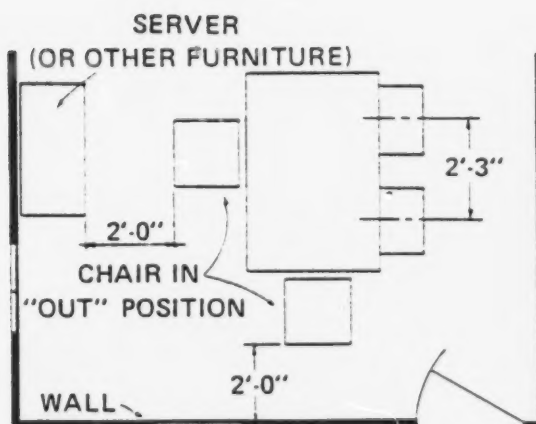


Closed Plan

DINING ROOM

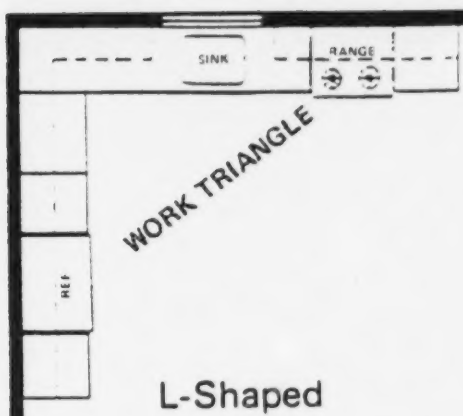


Typical Furniture Arrangement

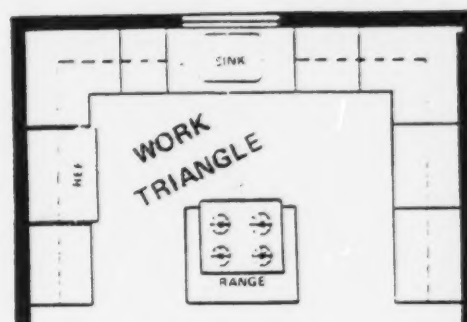


Clearances

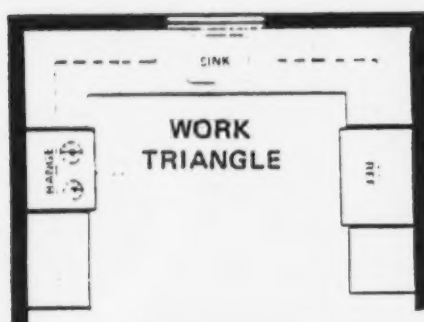
KITCHEN ARRANGEMENTS



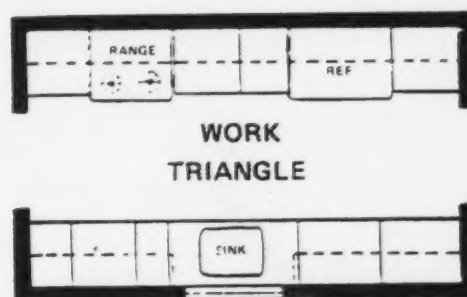
L-Shaped



Island



U-Shaped



Corridor

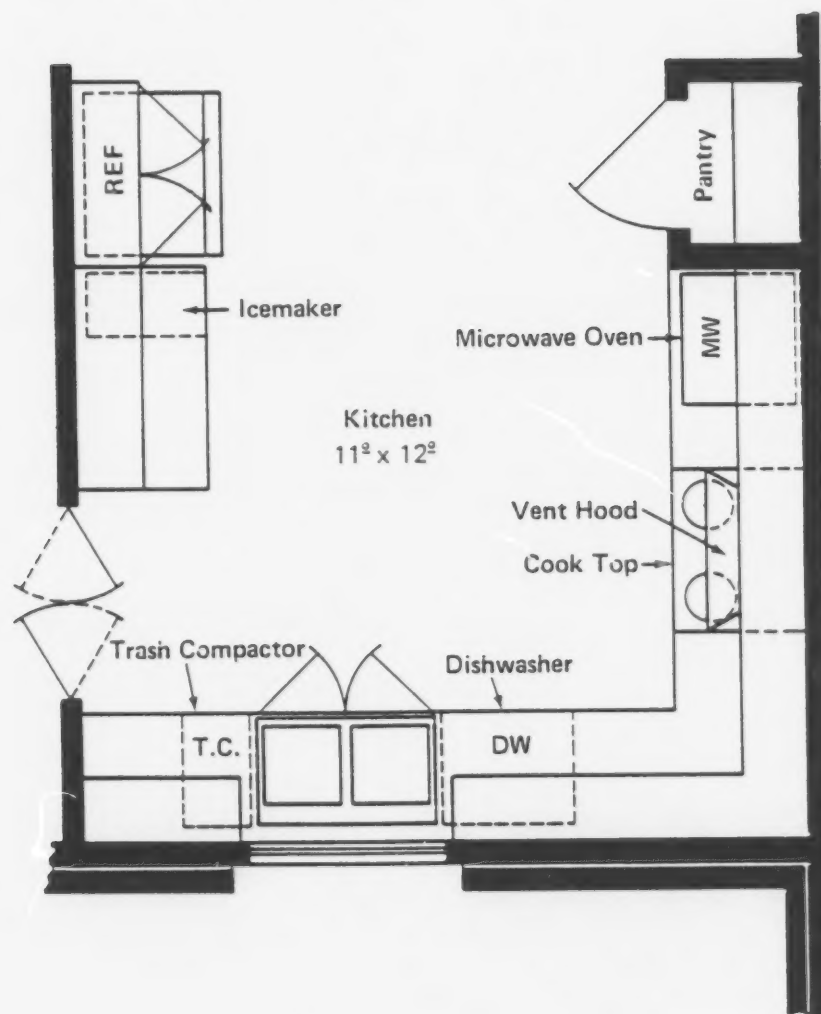


Peninsula



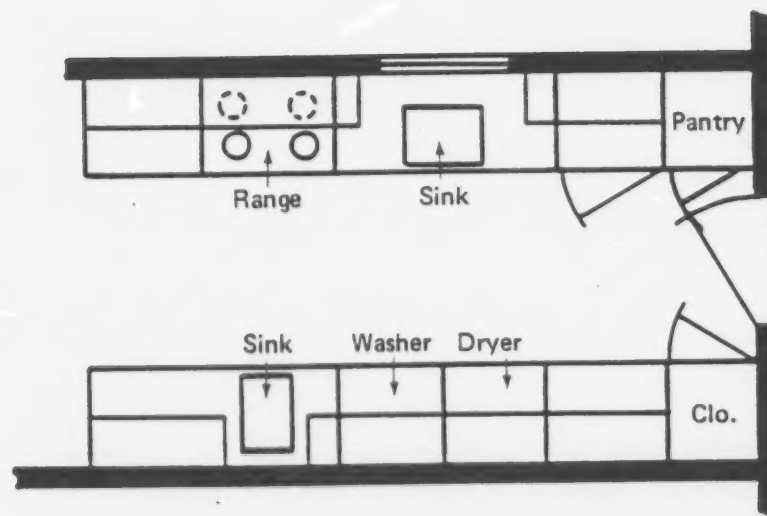
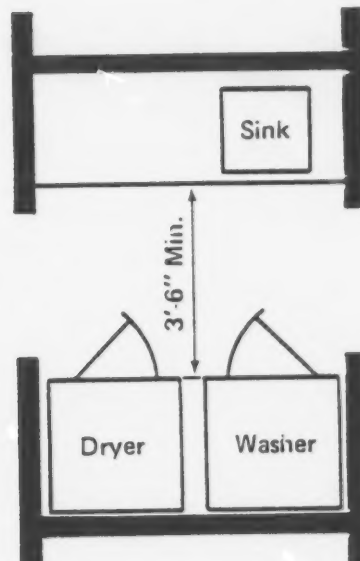
Straight Line (One wall)

KITCHEN



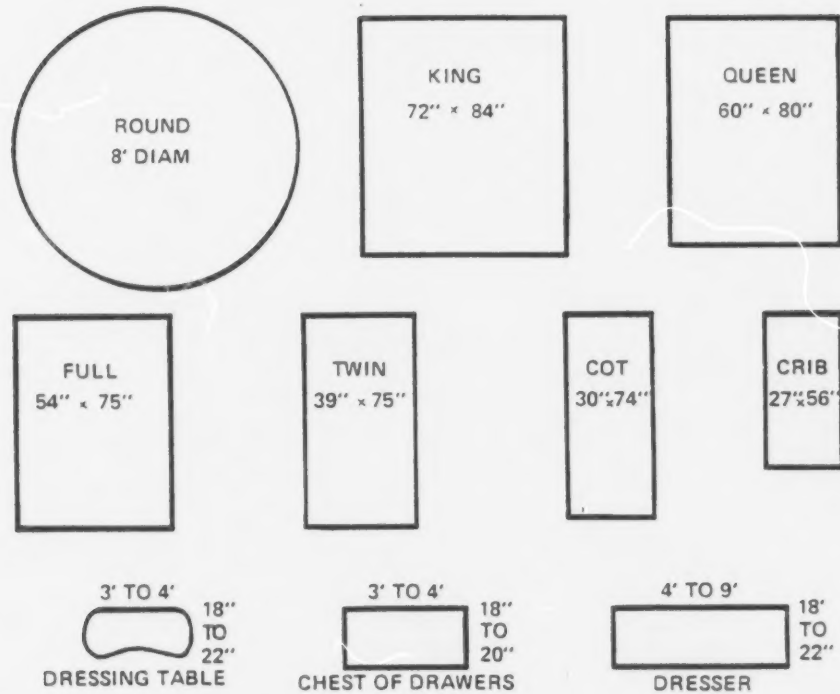
Storage is Placed Near Each Appliance

UTILITY ROOM

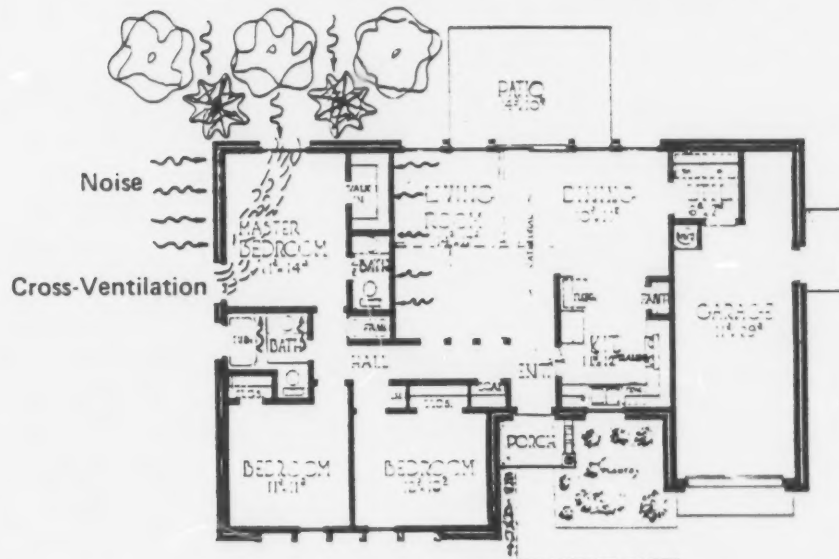


Kitchen/Utility Room Combination

BEDROOM

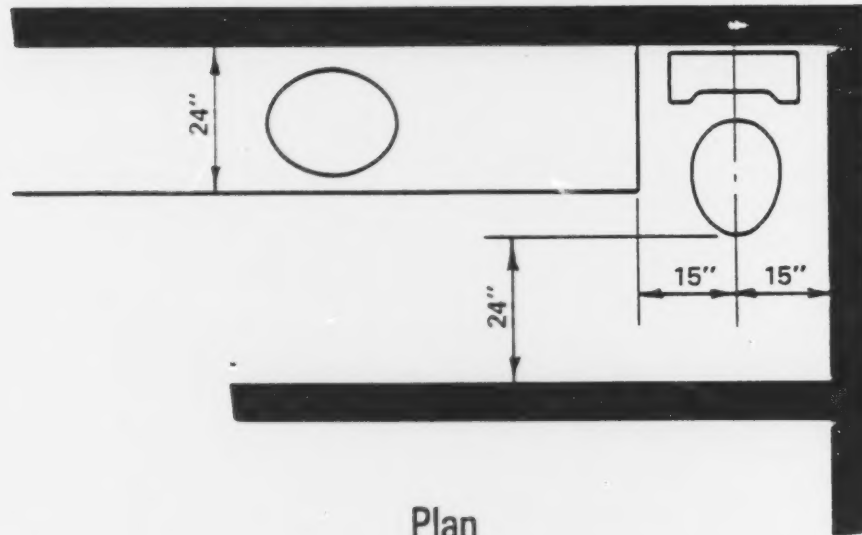


Typical Bedroom Furniture Sizes

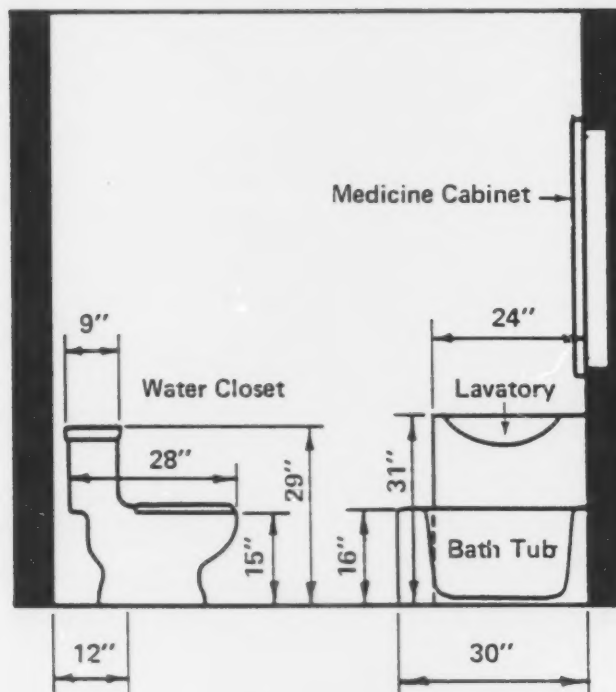


Noise Prevention and Cross-Ventilation

BATHROOM CLEARANCES



Plan

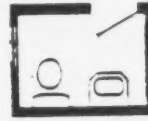


Elevation

BATHROOM SIZES

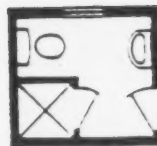


4'-3" x 4'-3"



5'-6" x 4'-3"

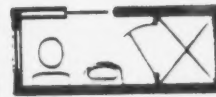
$\frac{1}{2}$



6'-0" x 5'-6"



4'-6" x 5'-6"

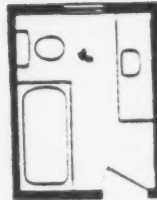


8'-6" x 3'-0"

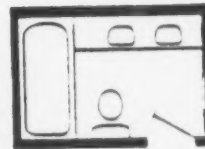
$\frac{3}{4}$



5'-0" x 7'-6"

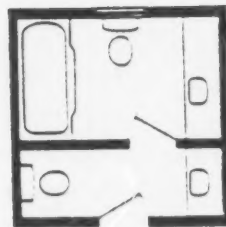


6'-0" x 8'-0"

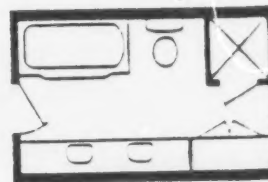


8'-0" x 5'-6"

Full



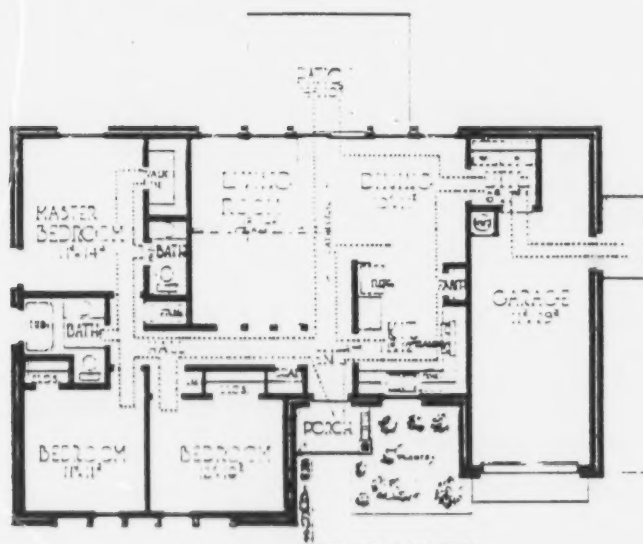
9'-0" x 9'-0"



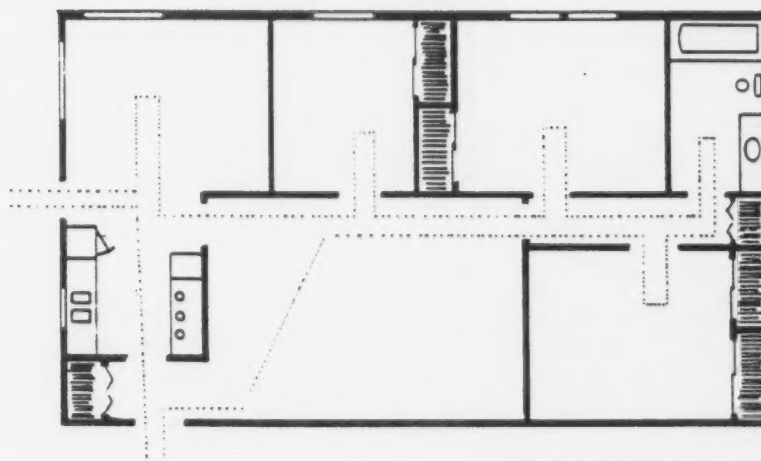
11'-0" x 7'-0"

Luxury

TRAFFIC PATTERNS



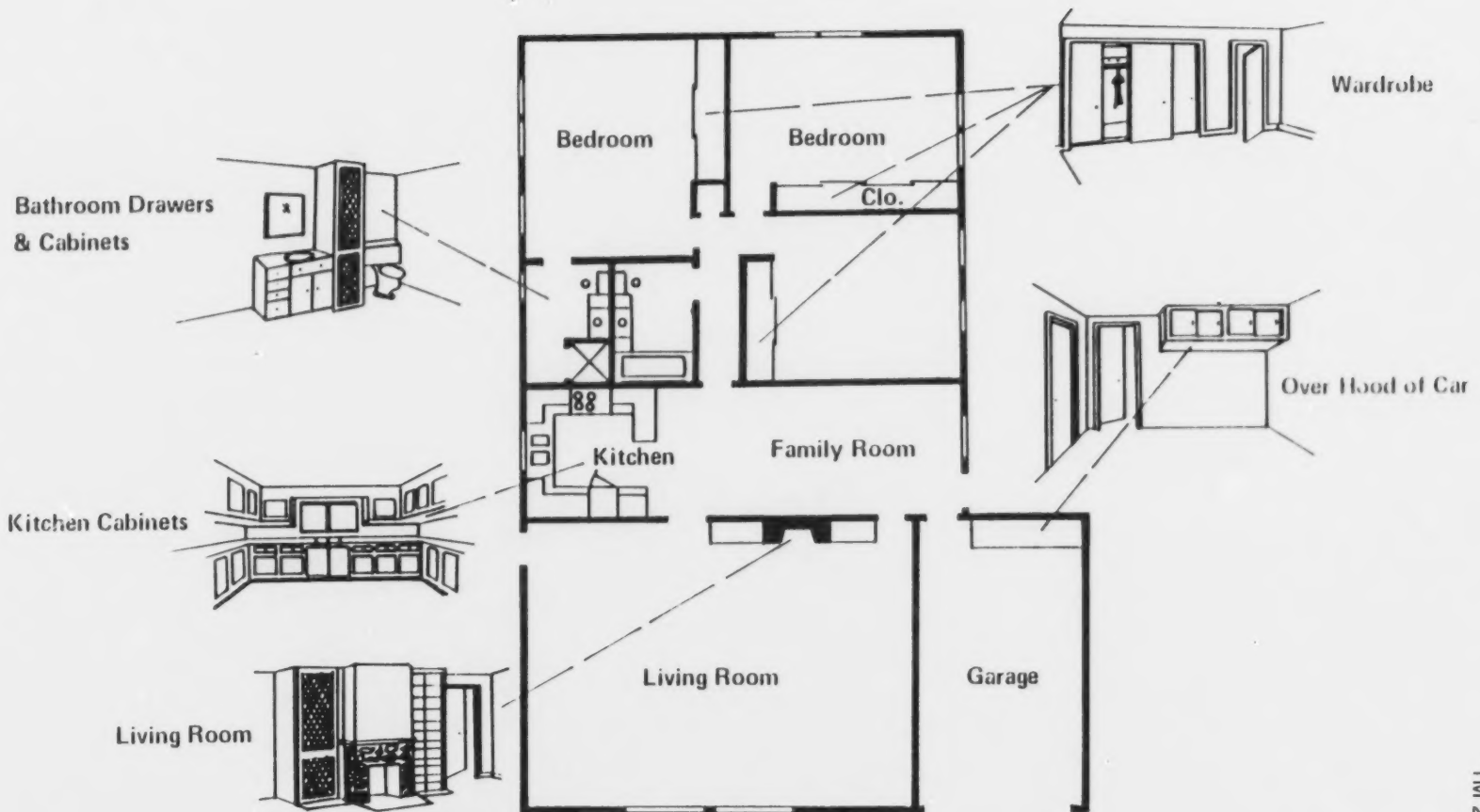
Well Designed



.....Show Traffic Flow

Poorly Designed

STORAGE AREAS

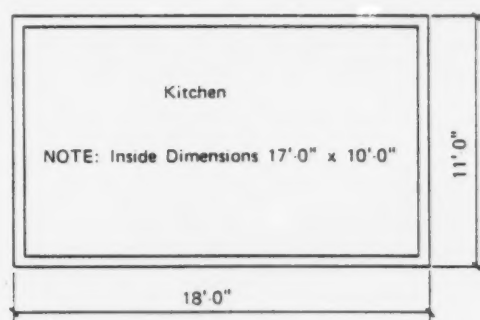


PLAN A KITCHEN

Directions: Plan a kitchen by using the procedure in the following example.

Example:

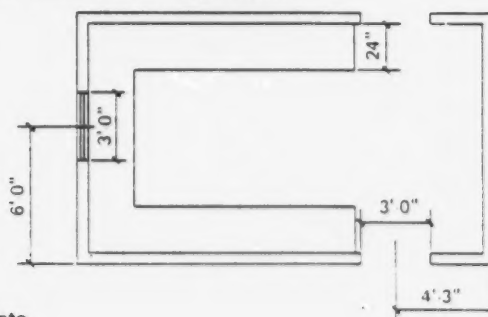
1. Determine overall room size.



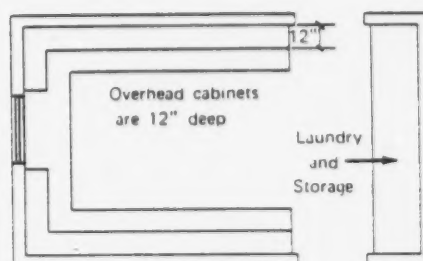
2. Locate and label all openings.
3. Determine kitchen arrangement. (TM 2.3)

NOTE: A U-shaped kitchen is used in this example.

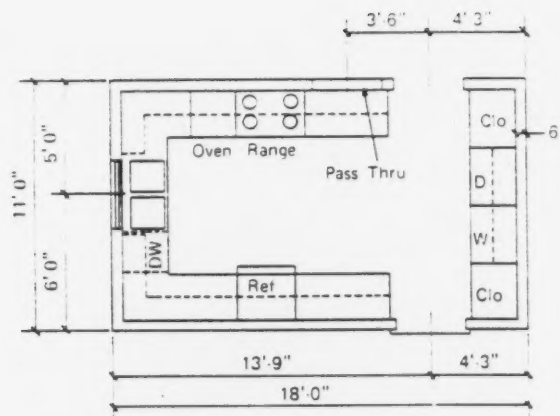
4. Determine areas for base cabinets and appliances.



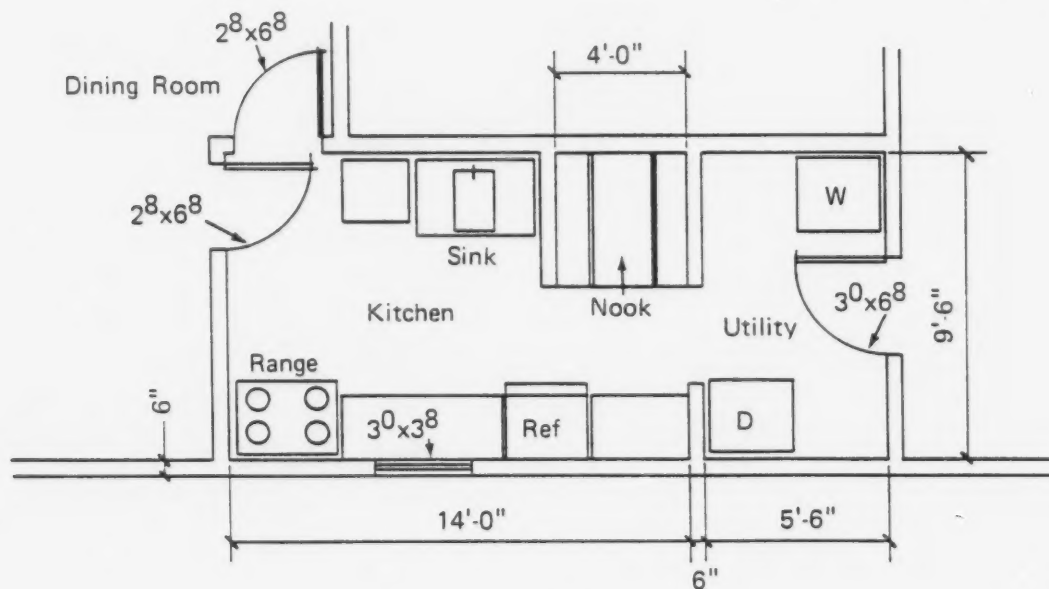
5. Locate overhead cabinets.



6. Arrange the appliances.
7. Detail all areas accurately.

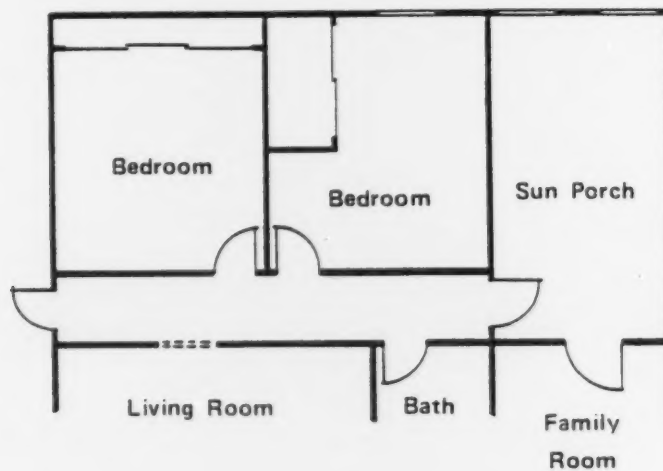


Problem: Draw a new plan for the kitchen below including details and dimensions. Outside walls cannot be changed. Include a work triangle. Scale $3/16" = 1'-0"$



PLAN A SLEEPING AREA

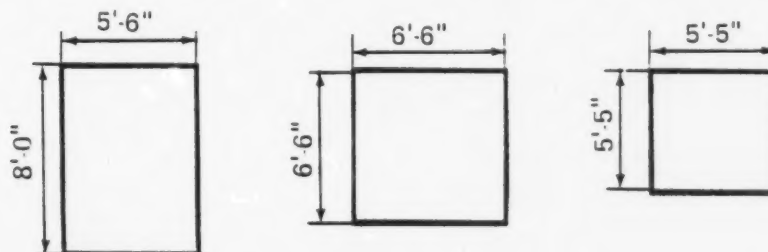
Directions: Draw a new plan for the sleeping area below which is for a family of four; 2 adults, 1 boy, and 1 girl.



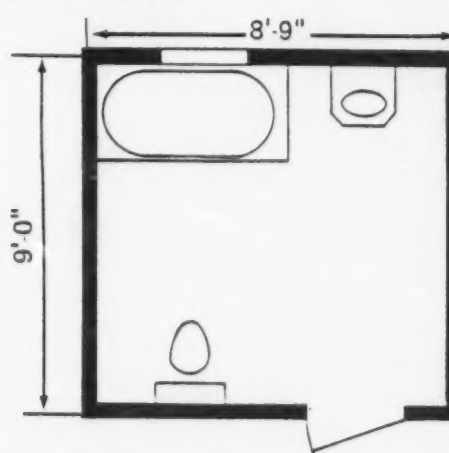
PLAN A BATHROOM

Directions: Plan bathrooms for the following problems.

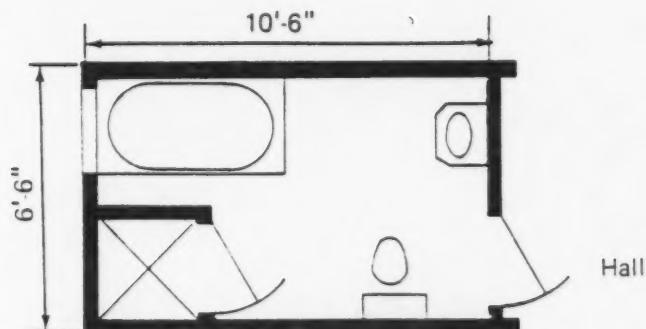
Problem A: Add lavatory, tub, and toilet to these plans; place door in any convenient location.



Problem B: Add storage to the bathroom below. You may want to draw a new plan for this bathroom, but size and door location may not be changed.



Problem C: Draw a new plan for the bathroom below. Add needed storage but do not change size or door location.



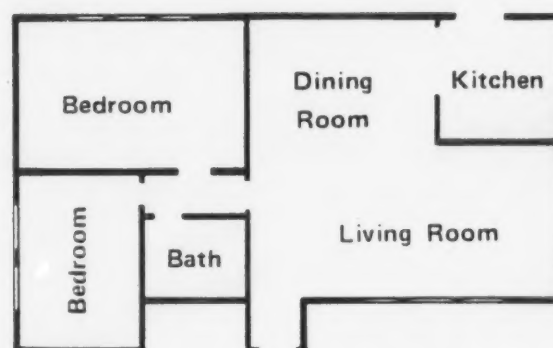
PLAN TRAFFIC PATTERNS

Directions: Examine the following floor plans to determine the traffic flow. Draw arrows to indicate the heaviest traffic patterns. List ways that you would suggest changing the plans to improve the flow of traffic.

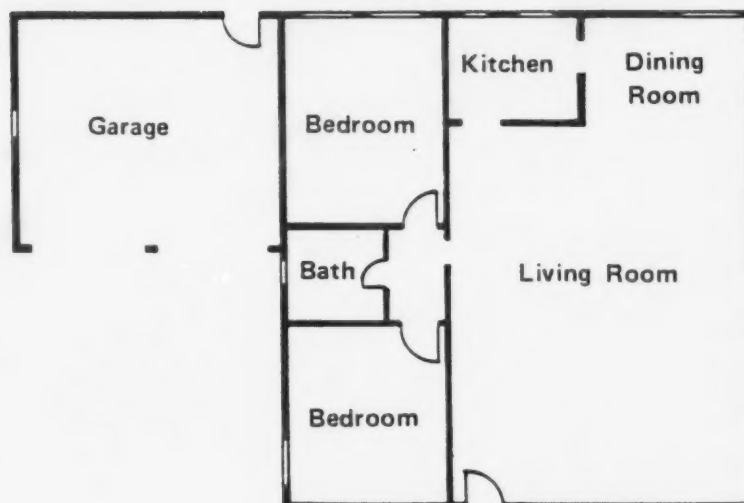
NOTE: If time permits, you may wish to redraw the plans to show the suggested improvement in the flow of traffic throughout the houses.

Problems:

A.



B.

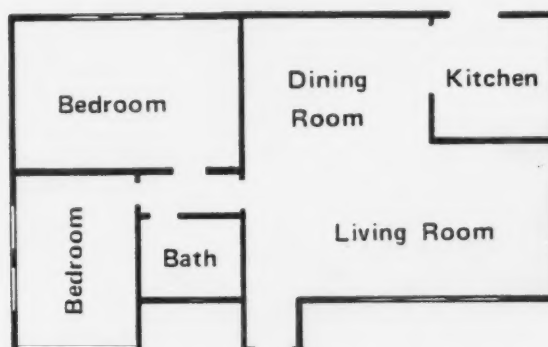


PLAN STORAGE FACILITIES

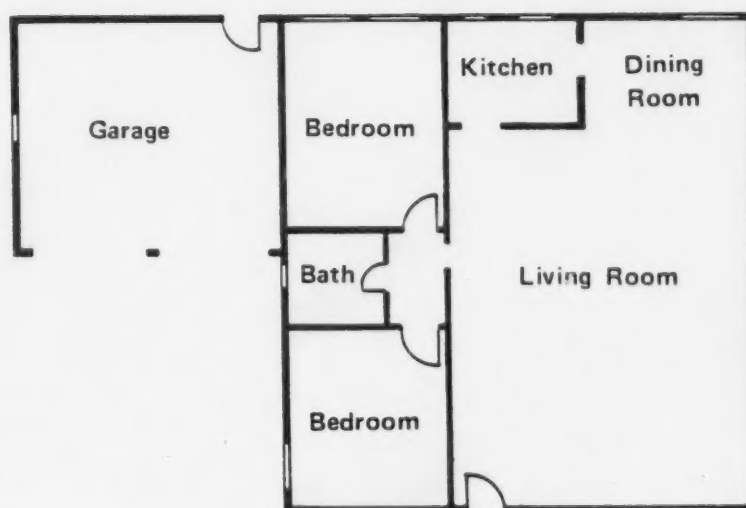
Directions: After carefully studying the following plans, determine what storage space you would recommend adding. Draw this storage space on the plan and label.

Problems:

A.



B.



DEVELOP A PRELIMINARY RESIDENTIAL SKETCH

Directions: Use the following information to develop a preliminary residential sketch.

Problem:

You are to design a residence for a Dallas couple and their one child. Your client is a professor of political science at SMU. His wife is an art instructor at a local private school and also very active in volunteer social work in the Dallas area. He is 38 and she is 36. Their son, 15, is a sophomore in high school.

The husband's leisure-time activities include research and study at home and outdoor activities such as mountain climbing. They frequently entertain groups ranging from small dinner parties to 20 or 30 at a cocktail party. Their son's hobby is electronics. He also shares his parents' enthusiasm for the outdoors.

They have purchased a 130' x 90' corner lot in the rapidly developing northeast part of Dallas. A beautiful creek runs across the back corner of the property. The lot is heavily wooded. The client insists that the property remain undisturbed and none of the existing trees cut down except where construction is necessary.

The residence is to be a one-story, wood-frame structure. The neighborhood deed restrictions state at least 75% of the exterior wall (non-widow area) must be brick or masonry. The restrictions also state that no building can be constructed within 25'-0" of any property line facing a street or within 10'-0" of any side property line.

The clients have set a budget of \$90,000 to \$100,000, not counting the cost of the land. Maximum square footage of the house is to be 2,600 SF including car storage.

This is to be a completely original design of your own choosing. The design solution should be a bold and exciting expression of contemporary architecture. The clients want neither the type of house you can find on every street in Dallas today nor a period piece or social symbol. The clients have established the following as their basic requirements.

1. Small entry area with a closet
2. Living area with a fireplace and wet-bar area; a warm, informal atmosphere with a good view of the outdoors
3. Dining area with an informal atmosphere
4. Kitchen with ample space for food preparation, large storage and pantry, plus small, informal eating area with outside view and access to patio
5. Powder room near entry with access to living area, dining area, and patio
6. Landscaped patio overlooking the creek for outdoor entertaining and relaxation
7. Utility area for washer, dryer, and freezer with small storage closet and laundry sink

8. Master bedroom with space for king-size bed, private bath, dressing areas, large closets, and access to a private patio
9. Boy's bedroom with work space for electronics, study area, ample storage and closet areas, and access to bath
10. Guest bedroom with bath
11. Small study with fireplace, next to master bedroom
12. Mechanical equipment area--hot water heater, air-conditioning equipment, and heater; area centrally located in the house
13. Garage or carport for two cars
14. Storage of 30 SF minimum for lawn, garden, and camping equipment
15. Ample general storage (linen closets, shelves, etc.)
16. Any other area the designer feels necessary that can be included within the maximum square footage

The following is a statement in the client's own words:

"We live in a quiet, informal, relaxed atmosphere. We do not like a house that has a series of boxes for rooms. Spaces that flow into one another and offer multiple use of the rooms are better for us. We love the out-of-doors, but we demand and enjoy our privacy in our surroundings. The distinct contrast between the inside of our home--the firelight, the books, and the paintings--and the natural outside should provide us with many years of pleasurable experience. All major living areas--living room, dining room, kitchen, and bedrooms--must have a view of the exterior.

The main room will be the living room. It should be a large, warm, friendly, and inviting room. We do a lot of entertaining, and this room will be the main focal point for our friends and guests. It should be oriented toward a fireplace. Large, comfortable seating areas must be provided. The room should open on to an outdoor patio. We see this room as having space and dignity and grace and warmth of tone, a sense of rich inwardness, accented by the outside. Sunken or high ceiling spaces would be appropriate.

Much of our entertaining is small dinner parties for six to ten people. The dining room must not seem to be a completely separate area of the house, but a warm and friendly space in which to enjoy one's friends and good food. The space should be informal with an intimate atmosphere to enhance the friendly mood at a dinner. It must be very accessible to the kitchen and provide storage space for linens, tableware, and wine. Our dining table seats six but can be expanded to seat ten.

The kitchen must not be "clinical" in atmosphere. It should be warm and sociable. It must provide sufficient preparation areas, maybe a kitchen island, space for refrigerator and a freezer, and ample storage and pantry areas. This does not necessarily mean a lot of square footage. The kitchen should be close to the carport or garage for bringing in groceries and accessible to the patio for outdoor eating and entertaining. An intimate, informal family eating area with a view of the creek must also be provided.

The master bedroom suite is to be our retreat. We want a light, airy space with some areas of glass to provide sunlight and a view. The adjacent study area is for reading, watching TV, or study. Ample bookshelves are necessary. Bath and dressing areas should approach the luxurious. A private outdoor patio is extremely desirable.

Our son's bedroom should be both a bedroom and a study area. He is approaching manhood. We want him to have freedom in his surroundings to develop. A nice view, work space for his electronic experiments, private bath, and ample storage areas are necessary.

The guest room should be a relatively small bedroom for our frequent overnight house guests. Closet space must be provided. Access to a bath area is mandatory. This may be in a compartmentalized arrangement with the powder room, or boy's bath, or a small private bath for the guest room only.

We want the contrast of spaces in our home to provide an ever-changing atmosphere. Changes in floor levels are required as are skylights and window areas that provide for changes of sunlight during the day. The sense of contrasting vertical space and form, creating visually large and interesting areas, is more important to us than ample square footage.

Energy conservation is extremely important to us. In these days of high fuel costs and shortages, our new home must be as energy efficient as possible."

NOTE: Keep your sketch for use in later units.

MAKE A SCALE DRAWING OF THE RESIDENTIAL SKETCH

Directions: Make a scale drawing of the residential sketch you drew in AS 2.6.

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT II: INTRODUCTION TO RESIDENTIAL DESIGN
ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT II: INTRODUCTION TO RESIDENTIAL DESIGN
UNIT TEST

1. List five items needed from client when planning a residence.

- a.
- b.
- c.
- d.
- e.

Select characteristics of a lot which can affect building design by placing an "a" in the appropriate blanks. Mark a "b" for characteristics which do not affect building design.

- ___ 2. Occupation of owners
- ___ 3. Relationship of front elevation and entries to the street
- ___ 4. Slope of lot
- ___ 5. Amount of topsoil
- ___ 6. Style of furniture wanted
- ___ 7. View
- ___ 8. Shape of lot

Distinguish between rooms located in basic areas of a house by placing an "a" for living area, a "b" for service area, and "c" for sleeping area in the appropriate blanks.

- ___ 9. Workshop
- ___ 10. Family room
- ___ 11. Bedroom
- ___ 12. Laundry
- ___ 13. Entrance
- ___ 14. Kitchen

Match the rooms in the living area on the right with the correct characteristics.

- | | | | |
|---------|---|-----|-----------------|
| ___ 15. | May be designed to serve as a guest bedroom | a. | Entrance |
| ___ 16. | Near the kitchen and usually near the living room | b. | Living room |
| ___ 17. | Area through which people enter the house | c. | Dining room |
| ___ 18. | Primarily used for formal or informal relaxation and recreation; may be used for almost any purpose | d. | Recreation room |
| | | e. | Family room |
| ___ 19. | May be located in basement, attic, or main level of house, depending upon available space; used as a play room or game room | ab. | Den |
| | | ac. | Porch |
| ___ 20. | Outside, near entrance according to occupants' needs/uses | | |
| ___ 21. | Use depends on family; usually for quiet activities such as work or study | | |
| ___ 22. | Used for family centered activities such as TV, music, or table games; usually located near the kitchen | | |
| ___ 23. | Used for formal or informal dining | | |

Match the rooms in the service area on the right with the correct characteristics.

- | | | | |
|---------|---|----|-------------------|
| ___ 24. | Attached, detached, or connected by a breezeway to the other service areas | a. | Kitchen |
| | | b. | Laundry |
| ___ 25. | Soundproofing and fire protection may be added; workbench; storage for supplies and tools | c. | Utility room |
| | | d. | Garage or carport |
| ___ 26. | Wash, store, and cook food | e. | Workshop |
| ___ 27. | May serve as laundry in addition to other areas such as storage, sewing, or food preservation | | |
| ___ 28. | Adjacent to dining room and outside entrance | | |
| ___ 29. | Provide shelter for one or more vehicles | | |
| ___ 30. | Wash, dry, and care for occupants' clothing | | |

Select true statements concerning factors to observe when planning the flow of traffic between rooms by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- ___ 31. Plan for the heaviest flow of traffic to occur between the kitchen and dining areas, the bedrooms and bath, and the living and dining areas.
- ___ 32. A kitchen does not need to be adjacent to service entrance.
- ___ 33. Always locate the garage or carport adjacent to the bedrooms and have an entrance permitting easy access into them.
- ___ 34. Dining area should be next to the bedrooms and have an entrance permitting easy access into them.
- ___ 35. Each bedroom should have access to kitchen.
- ___ 36. Bedrooms should have easy access to a bath.
- ___ 37. Plan to be able to enter a house and go to the bedroom area or bath without crossing through the living area.

Match categories of storage facilities on the right with the correct descriptions.

- | | |
|---|------------------------|
| ___ 38. Shallow closets in the wall, holding cupboards, shelves, and drawers | a. Wardrobe closets |
| ___ 39. Shallow clothes closets built into the wall | b. Walk-in closets |
| ___ 40. Free standing pieces of furniture used for storage | c. Wall closets |
| ___ 41. Free standing storage facilities which may be used to divide a large space into smaller areas | d. Chests and dressers |
| ___ 42. Closets which are large enough to walk into | e. Room dividers |

43. Complete the following chart of characteristics of rooms in the sleeping area.

Room	Purpose	Suggested Minimum Size	Extra Features	Location
a. _____	Quiet activities such as sleeping, resting, or reading	Room--100 sq. ft. Door--2'-8" x 6'-8"	b. _____ c. _____ d. _____	Quiet part of house
Bathroom	e. _____ f. _____ g. _____	Room--h. _____ Door--2'-0" x i. _____	Storage space; ventilation	j. _____ k. _____

44. What is the general rule to remember when planning the flow of traffic?
45. Sequence the steps for making a preliminary residential sketch: #1 represents 1st step, #2 represents 2nd step, etc.
- ___ Select an architectural style
 - ___ Combine rooms into areas
 - ___ Determine client needs
 - ___ Make furniture templates
 - ___ Arrange furniture templates
 - ___ Make a list of furniture needed
 - ___ Design outside by projecting elevations
 - ___ Determine sizes of furniture
 - ___ Combine areas into floor plan
 - ___ Determine room dimensions

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT II: INTRODUCTION TO RESIDENTIAL DESIGN

ANSWERS TO UNIT TEST (K-2)

- | | | | | |
|-----|----|--|-----|---|
| 1. | a. | Financial ability of client | 24. | d |
| | b. | What the client wants | 25. | e |
| | c. | Minimum requirements of the client | 26. | a |
| | d. | Client's preference in architectural style | 27. | c |
| | e. | Lot size and location | 28. | a |
| 2. | b | | 29. | d |
| 3. | a | | 30. | b |
| 4. | a | | 31. | a |
| 5. | b | | 32. | b |
| 6. | b | | 33. | b |
| 7. | a | | 34. | b |
| 8. | a | | 35. | b |
| 9. | b | | 36. | a |
| 10. | a | | 37. | a |
| 11. | c | | 38. | c |
| 12. | b | | 39. | a |
| 13. | a | | 40. | d |
| 14. | b | | 41. | e |
| 15. | ab | | 42. | b |
| 16. | c | | 43. | (see chart below) |
| 17. | a | | 44. | People must be able to move from room to room and from one part of the house to another with a minimum of congestion and unnecessary steps. |
| 18. | b | | | |
| 19. | d | | | |
| 20. | ac | | | |
| 21. | ab | | 45. | 3, 8, 1, 5, 6, 2, 10, 4, 9, 7 |
| 22. | e | | | |
| 23. | c | | | |

43.

Room	Purpose	Suggested Minimum Size	Extra Features	Location
a. <u>Bedroom</u>	Quiet activities such as sleeping, resting, or reading	Room--100 sq. ft. Door--2'-8" x 6'-8"	b. <u>closets</u> c. <u>windows</u> d. <u>ventilation</u>	Quiet part of house
Bathroom	e. <u>personal hygiene</u> f. <u>may provide other functions such as laundry</u> g. <u>or dressing</u>	Room--h. <u>5' x 8'</u> Door--2'-0" x i. <u>6'-8"</u>	Storage space; ventilation	j. <u>near bedrooms</u> k. <u>near service area</u>

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT III: DIMENSIONING ARCHITECTURAL DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms related to dimensioning with the correct definitions; distinguish between the correct and incorrect uses of dimensioning; complete a chart for drawing wall thickness; and select true statements concerning general dimensioning rules, floor plan dimensioning, elevation dimensioning, and detail and wall dimensioning; complete a chart of dimensioning abbreviations; and arrange in order the steps for drawing a wall section detail. The student should also be able to dimension a floor plan, dimension an elevation, and draw a wall section detail. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

- 3.1 Match terms related to dimensioning with the correct definitions.
- 3.2 Distinguish between the correct and incorrect uses of dimensioning.
- 3.3 Complete a chart for drawing wall thickness.
- 3.4 Select true statements concerning general dimensioning rules.
- 3.5 Select true statements concerning floor plan dimensioning.
- 3.6 Select true statements concerning elevation dimensioning.
- 3.7 Select true statements concerning detail and wall section dimensioning.
- 3.8 Complete a chart of dimensioning abbreviations.
- 3.9 Arrange in order the steps for drawing a wall section detail.
- 3.10 Demonstrate the ability to:
 - a. Dimension a floor plan. (AS 3.1)
 - b. Dimension an elevation. (AS 3.2)
 - c. Draw a wall section detail. (AS 3.3)

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT III: DIMENSIONING ARCHITECTURAL DRAWINGS
CONTENTS OF THIS UNIT

- A. Objective sheets
- B. References
- C. Notes to the instructor
- D. Lesson plan
 - 1. **Lesson 1: Dimensioning and Details** 105
 - a. Information Outline
 - b. Transparency masters
 - TM 3.1: Arrowheads and Leaders
 - TM 3.2: Floor Plan Dimensioning
 - TM 3.3: Exterior Wall Dimensioning
 - TM 3.4: Elevation Dimensioning
 - TM 3.5: Wall Section Dimensioning
 - TM 3.6: Drawing a Wall Section Detail
 - TM 3.7: Drawing a Wall Section Detail (Continued)
 - c. Assignment sheets
 - AS 3.1: Dimension a Floor Plan
 - AS 3.2: Dimension an Elevation
 - AS 3.3: Draw a Wall Section Detail
 - d. Answers to assignment sheets
- E. Unit test
- F. Answers to unit test

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- J. Wakita, Osamu A. and Richard M. Linde. The Professional Practice of Architectural Detailing. New York, NY: John Wiley & Sons, Inc., 1970.
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- L. Willis, Charles D. Blueprint Reading for Commercial Construction. Albany, NY: Delmar Publishers/Litton Educational Publishing, Inc., 1979.
- M. Wyatt, William E. General Architectural Drawing. Peoria, IL: Charles A. Bennett Co., Inc., 1969.

NOTES TO THE INSTRUCTOR

- A. Suggested approaches to teaching this unit
 - 1. Discuss the various methods of dimensioning.
 - 2. Provide a set of residential working drawings as a reference for students.
 - 3. Provide 8 x 8 fade-out gridded vellum for use in all sketch assignments.
 - 4. Discuss the suggested pencil lead grades (HB, H, etc.) for various lines.
 - 5. Provide examples of section detail drawings of residential buildings.
 - 6. Provide manufacturers' catalogs of appliances, cabinets, prefabricated fireplaces, doors, and windows for use with the assignment sheets.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT III: DIMENSIONING ARCHITECTURAL DRAWINGS

LESSON 1: DIMENSIONING AND DETAILS

I. Terms and definitions

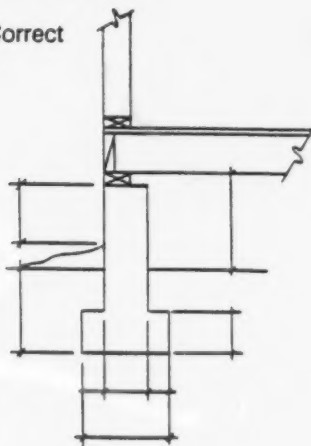
- A. **Call out**--specific note that is directed to a specific point on the drawing by the use of a leader
- B. **Detail dimension**--dimension for a small part
- C. **Dimensioning**--recording the actual size of the building and its many parts accurately on a drawing
- D. **General notes**--notes which give procedures or information, usually placed at bottom or right hand of sheet
- E. **Location dimension**--dimension that locates a feature on an object
- F. **Modular system**--where most materials are equal in size to an established module or a multiple of that module
- G. **Module**--a standard unit of measurement
- H. **Overall dimension**--dimension showing the total length of an object
- I. **Size dimension**--dimension which tells how large or small an object is
- J. **Special notes**--notes which give the name of kinds of materials or operations

NOTE: Even though identical materials are called out on other details, sections, elevations, or on same sheet, it is standard practice to identify all materials again.

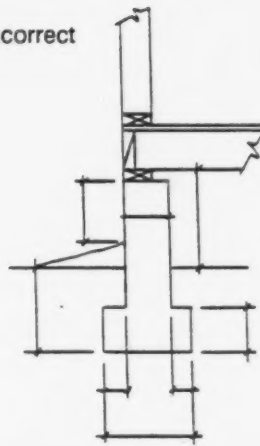
II. Correct and incorrect uses of dimensioning

A. Group dimension lines

1. Correct

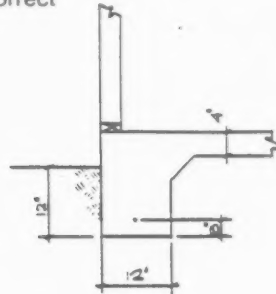


2. Incorrect

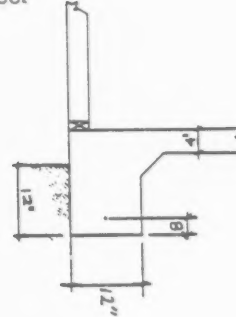


B. Location dimensions

1. Correct

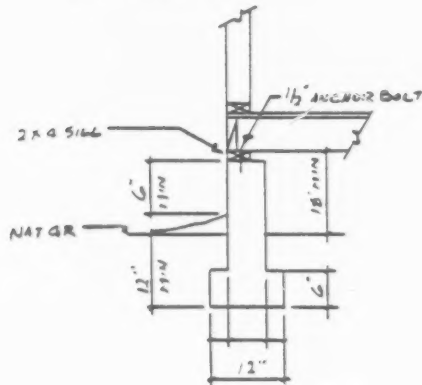


2. Incorrect

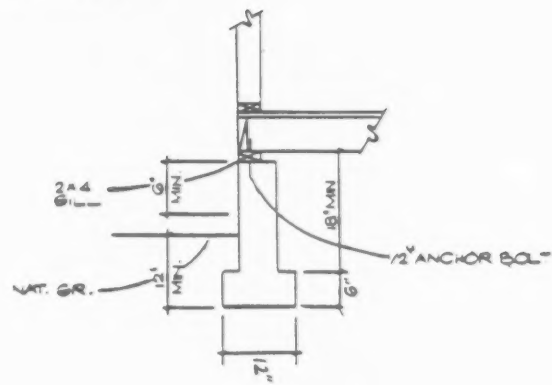


C. Crossing dimension lines

1. Correct

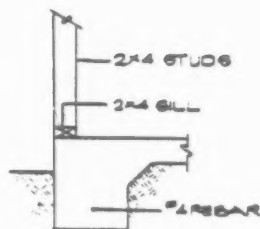


2. Incorrect

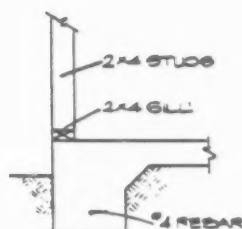


D. Leaders

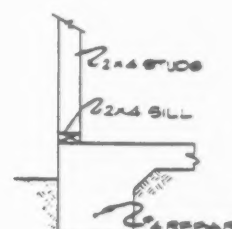
1. Best



2. Acceptable

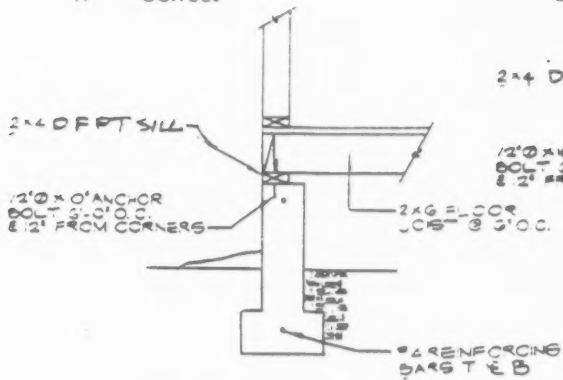


3. Not recommended

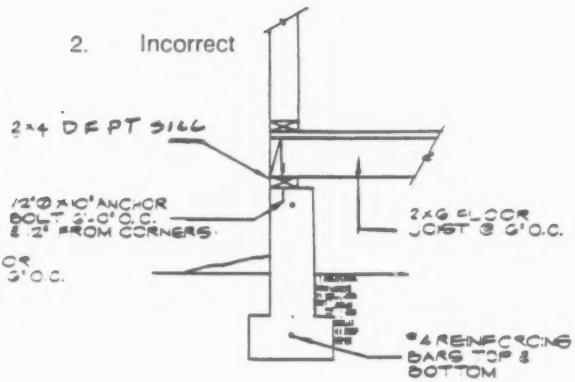


E. Location of leaders

1. Correct

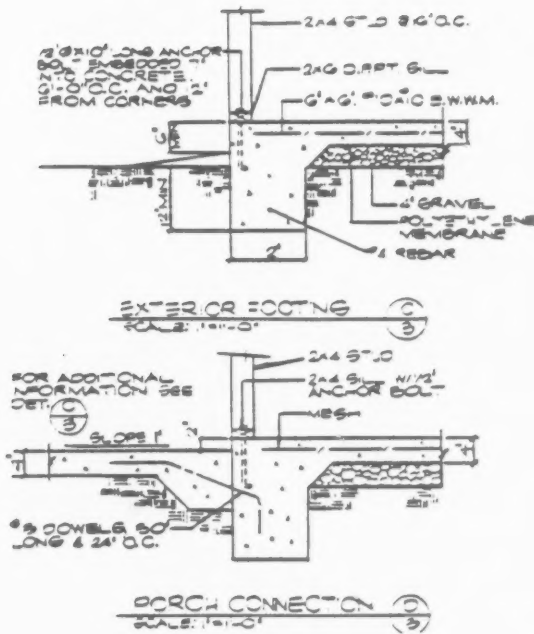


2. Incorrect

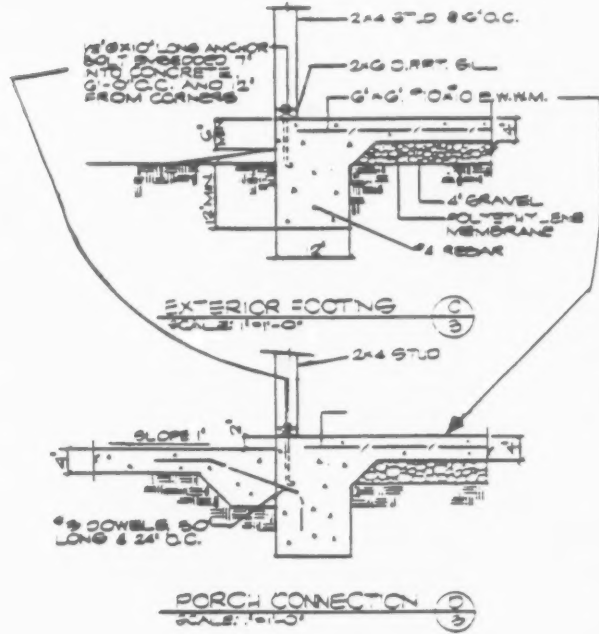


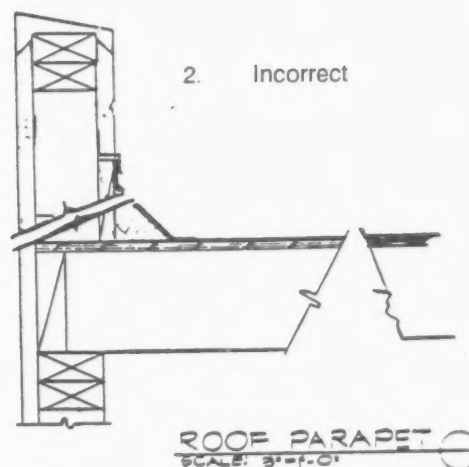
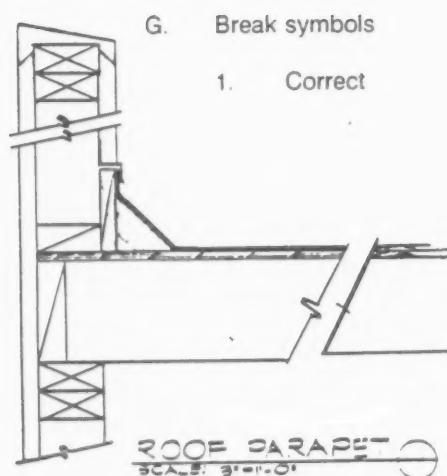
F. Note sharing

1. Correct



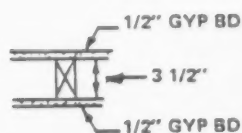
2. Incorrect



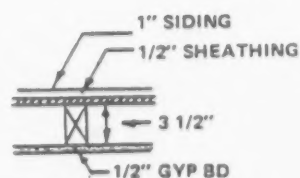


III. Drawing wall thickness

A.	Wood frame walls	Actual size	Drawn size
1.	Interior	4 1/2"	5"
2.	Interior (with vent pipe plumbing)	6 1/2"	6 to 8
3.	Exterior	5"	6"



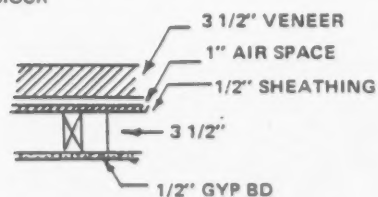
4 1/2" Interior Wall



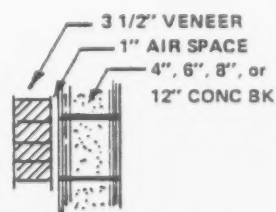
5" Exterior Wall

NOTE: Thickness of exterior walls may vary because of rigid insulation siding materials.

B.	Brick veneer walls	Actual size	Drawn size
1.	Veneer on frame	9"	10"
2.	Veneer on conc. block		



9" Exterior Wall

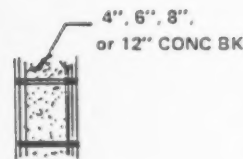


Veneer Masonry Wall

- C. Concrete Masonry
unit walls

4", 6", 8",
or 12"

4", 6", 8",
or 12"



Masonry Wall

IV. General dimensioning rules (TM 3.1)

- A. Everything is dimensioned the actual size, even though it is drawn to scale.
- B. Dimensions should not be crowded; keep dimensions at least 3/8" from the drawing and from each other.
- C. An unbroken dimension line should be used and the dimension should be placed above it.
- D. Distances over 12" are recorded as feet and inches.

NOTE: If the distance is an even number of feet, record the inches with a zero.

Example: 8'-0"

- E. Distances less than one foot are given in inches.
Example: 6", not 0'-6"
- F. Dimensions are placed on a drawing so they can be read from the bottom or right side of the drawing.

NOTE: This is the aligned method.

- G. Every drawing and detail should have the scale indicated even if on the same page and drawn to the same scale.
- H. Anything unusual should be explained with a note.

NOTE: Notes are lettered horizontally so they can be read from the bottom of the page and the letters are usually 1/8" high.

- I. Dimension lines are drawn thinner than visible lines used to draw the views.
- J. Extension lines should not cross dimension lines.
- K. Extension lines may cross each other.
- L. Do not dimension to hidden lines unless there is no other way.
- M. Whenever possible, line up a series of dimensions.
- N. Place the shortest dimensions near the object; the overall dimension should be on the outside.

- O. When a space to be dimensioned is too small to receive the figures, place them outside of it.
 - P. Dots or 45° diagonal lines may be used in place of arrowheads.
- NOTE: Do not mix dots, diagonal lines, and arrows.**
- Q. Dimension numerals and notes are lettered 1/8" high.
 - R. North arrow should be attractive but simple on floor and plot plan.

Examples:



V. Floor plan dimensioning (TM 3.2)

NOTE: The floor plan probably contains more information and references than any other sheet in a set of working drawings.

- A. Dimensions are placed on all sides of the plan.

NOTE: Aligned method is used.

- B. All projections or offsets are dimensioned.
- C. Overall dimensions are placed on all sides of the drawing.

NOTE: The builder should not have to add or use a scale to find a dimension.

- D. Cumulative dimensions should be added to see that their total equals the overall dimension.
- E. Identify fixtures and built-in items which cannot be clearly drawn, such as a clothes chute, dishwasher, or garbage disposal.
- F. The size and direction of ceiling joists and floor joists can be shown by symbol and noted.
- G. Rooms are identified by name, such as living room.

NOTE: The bedrooms should be numbered to assist the builder when decisions are made concerning the color of paint in the room and other related decisions.

- H. The size and depth of the fireplace opening are commonly shown, and hearth material is indicated.
- I. The width and length of each room are given, and interior walls are located by dimensioning to the center line of wall.
- J. When dimensioning an exterior frame wall, the dimension extends over the stud.
- K. When dimensioning an exterior masonry veneer wall, 5" is allowed beyond the face of the wall.

NOTE: The veneer overall dimension is given.

- L. Doors and windows in frame walls are dimensioned to their center lines.

NOTE: These dimensions are located on the floor plan.

- M. Doors and windows in solid masonry walls are usually dimensioned to the masonry sides of the opening. (TM 3.3)

NOTE: These dimensions are located on the floor plan.

- N. Door and window sizes can be lettered directly or coded on the floor plan to a door and window schedule.

NOTE: Several code systems are commonly found; one may use numbers for doors and letters for windows.

- O. Any change in floor elevation must be indicated by a line plus a note.

- P. Floor materials with varying thicknesses must be shown by a solid line and noted.

- Q. Columns, beams, and piers are located by dimensions to their center lines.

- R. All obvious dimensions are omitted.

NOTE: Interior floors, permanent fixtures, or cabinet doors are not dimensioned.

- S. Areas to be cut or filled should be noted.

- T. Materials in concrete floors should be noted.

VI. Elevation dimensioning (TM 3.4)

- A. The ceiling line and finished floor line are indicated and the total distances between these are shown.

- B. Roof slope is indicated by the symbol. 

- C. Exterior materials are noted such as brick, asphalt shingles, or board and batten siding.

- D. The overhang of the roof at the eaves is frequently dimensioned.

- E. The finished grade is indicated by a note.

- F. Window sizes and door sizes are sometimes lettered below the door or window, but the door and window schedule is preferred.

- G. Heights of chimneys above the ridge are dimensioned.

- H. Crawl space is called out.

VII. Detail and wall section dimensioning (TMs 3.5, 3.6 and 3.7)

- A. The dimensions, material, and location of all members in a wall section are specified.

- B. Draw materials to their **actual** sizes.

- C. Materials are noted to their **nominal** sizes.
- D. The floor, fill, foundation wall, and footing are dimensioned.
- E. Finished floor to finished ceiling distance is specified.
- F. Cabinets and other built-ins require only intermediate and overall dimensions.
- G. Fireplace details should be completely dimensioned, and materials should be indicated with a note.
- H. Stair details should have tread and riser indicated and total stair rise and run noted.
- I. Notes should be kept in straight line for neatness.

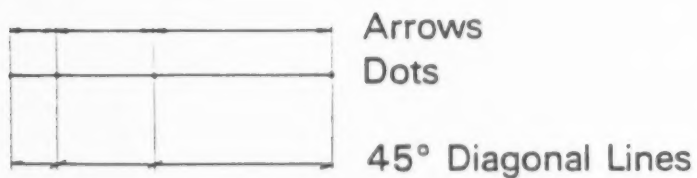
VIII. Dimensioning abbreviations

Air conditioning	A/C	Furred	FUR
Anchor bolt	AB	Hot water	HW
Asphalt	ASPH	Joint	JT
Basement	BSMT	Kitchen	KIT
Bedroom	BR	Lavatory	LAV
Block	BLK	Living room	LR
Building	BLDG	Long	LG
Cabinet	CAB	Masonry opening	MO
Ceiling	CLG	Medicine cabinet	MC
Ceiling joist	CJ	On center	OC
Center to center	C to C	Overhead	O.H.
Closet	CL	Refrigerator	REF
Column	COL	Reinforcing bar	REBAR
Concrete	CONC	Sheathing	SHTHG
Dining room	DR	Siding	SDG
Dishwasher	DW	Sill cock	SC
Dryer	D	Specification	SPEC
Each way	E.W.	Veneer	VNR
Elevation	EL	Washer	W
Finish	FIN	Water closet	WC
Fireplace	FPL	Weatherproof	WP
Floor	FL	Wire mesh	WM
Foundation	FND		
Frame	FR		
Furnace	FURN		

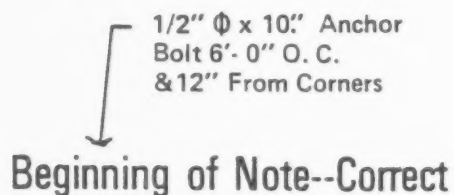
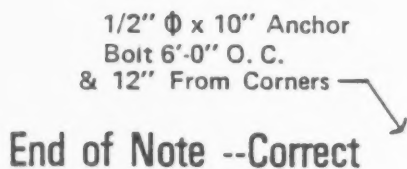
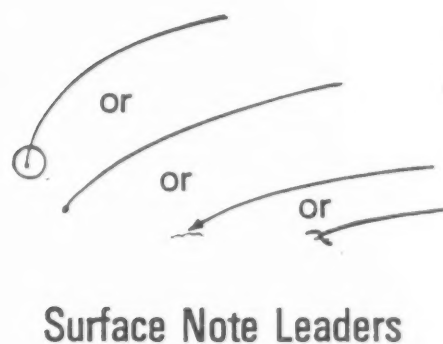
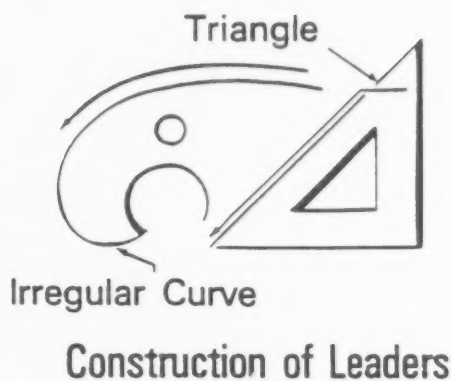
IX. Steps for drawing a wall section detail (TMs 3.6 and 3.7)

- A. Draw horizontal projection lines lightly.
- B. Draw vertical projection lines lightly.
- C. Add material thickness and primary detail.
- D. Add other detail sections.

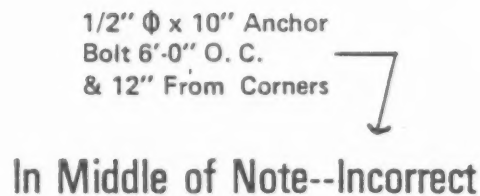
ARROWHEADS AND LEADERS



Arrowhead Types

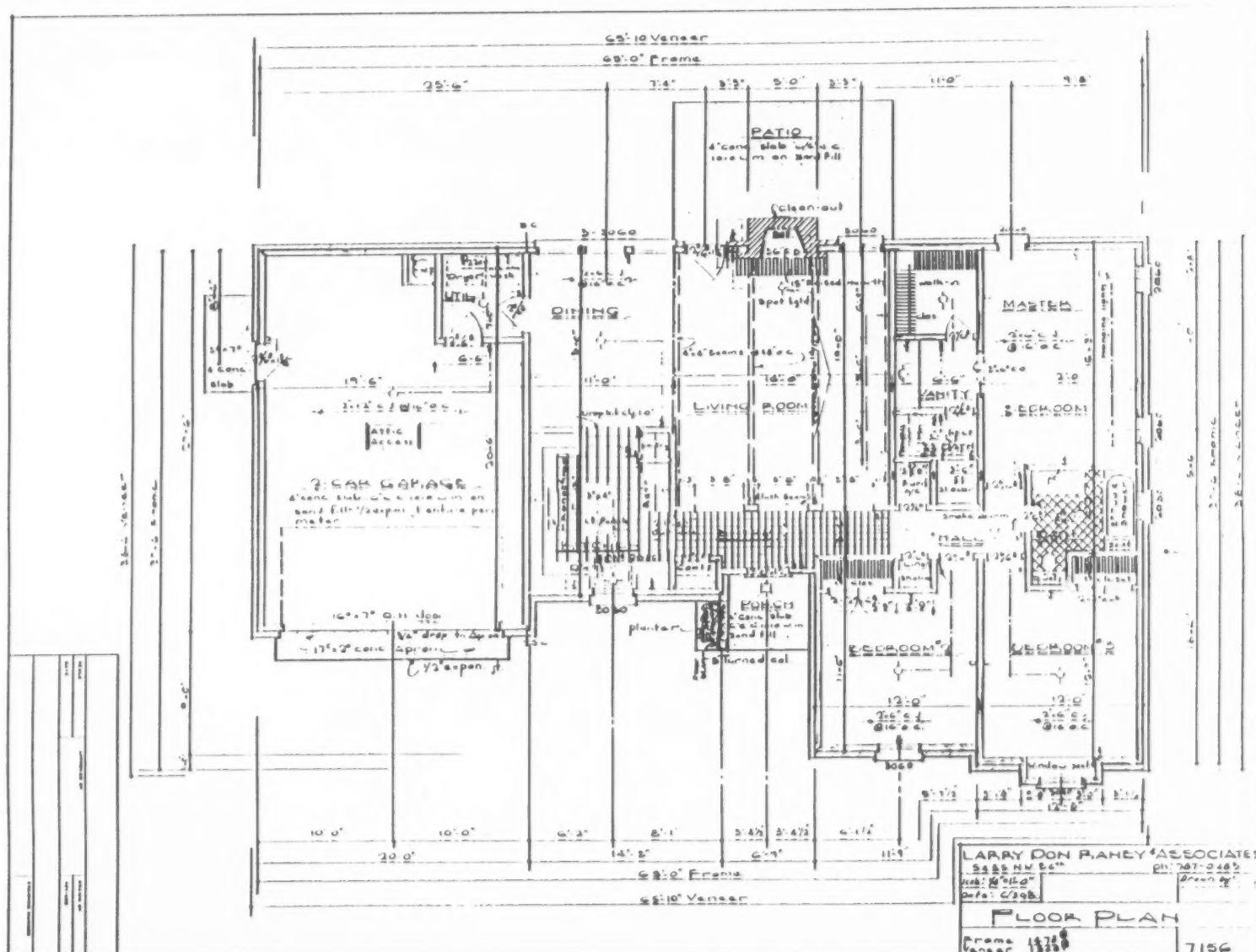


Leader Origin

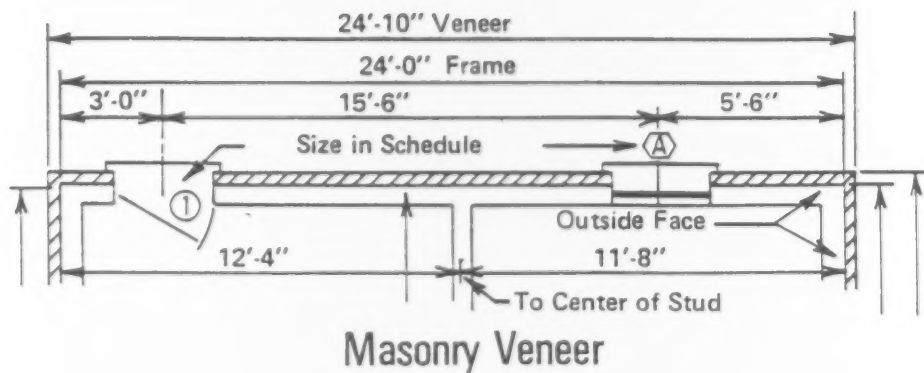
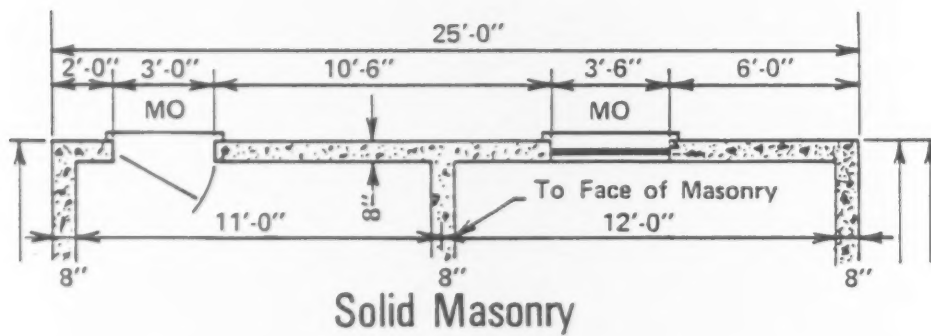
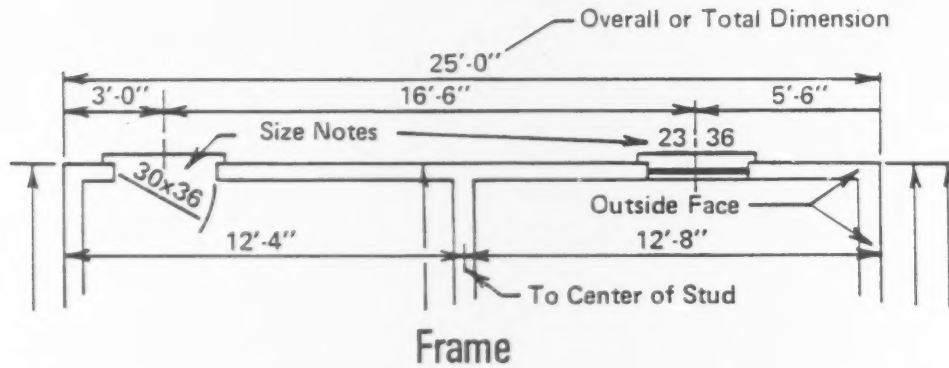


FLOOR PLAN DIMENSIONING

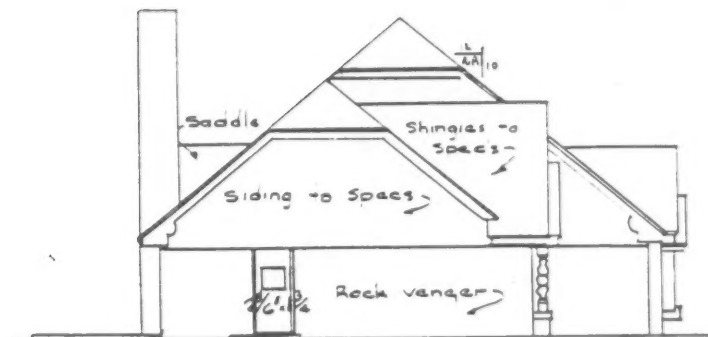
BEST COPY AVAILABLE



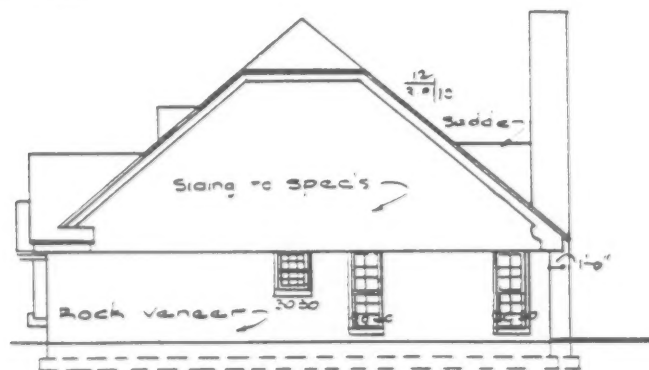
EXTERIOR WALL DIMENSIONING



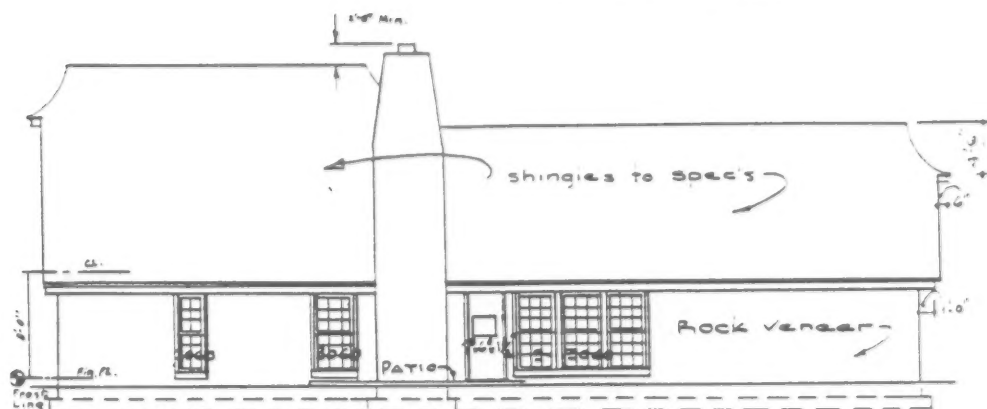
ELEVATION DIMENSIONING



LEFT SIDE



RIGHT SIDE

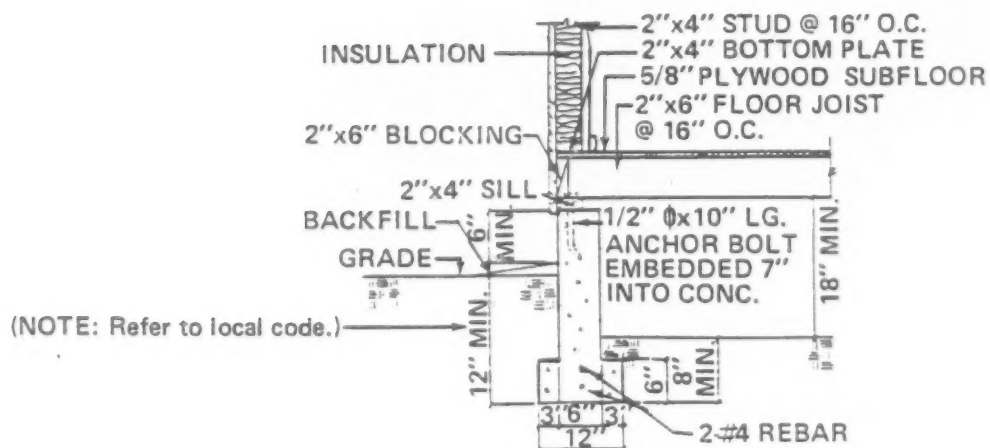
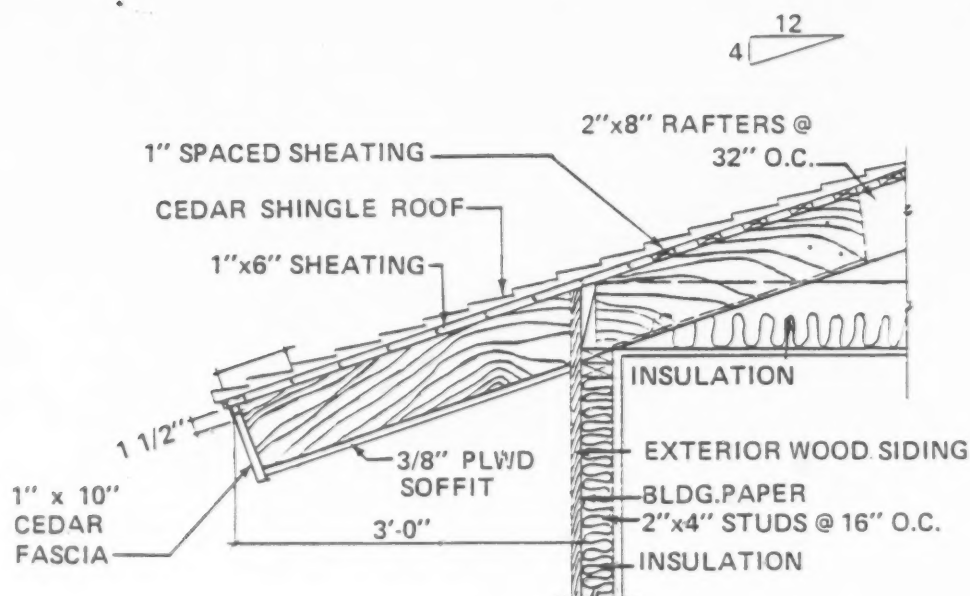


REAR

Scale: 1/8" = 1'-0"

(Note: Since the front elevation is often rendered, the dimensioning information is shown on other views.)

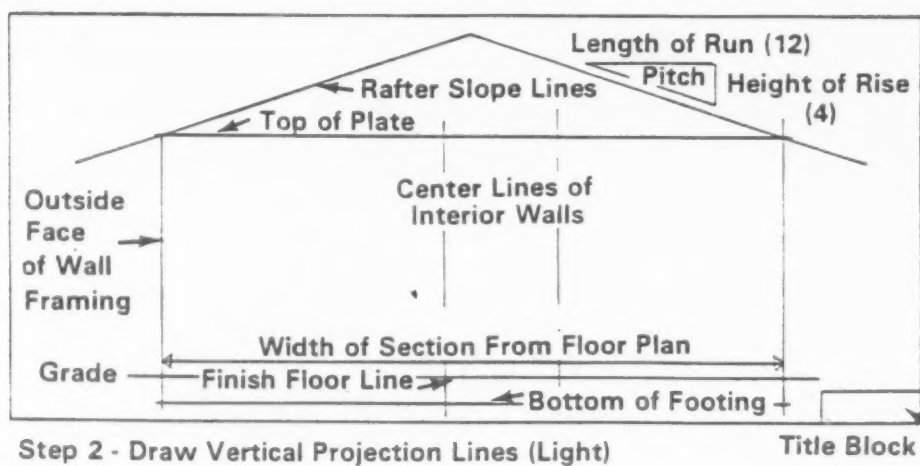
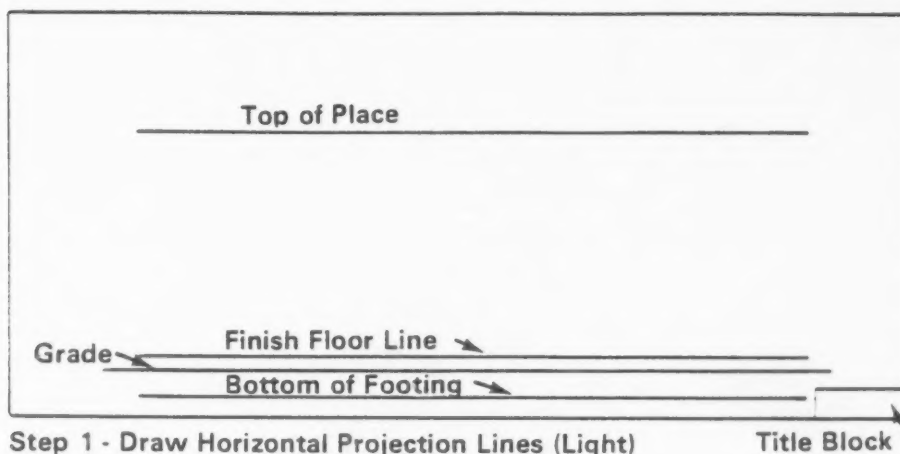
WALL SECTION DIMENSIONING



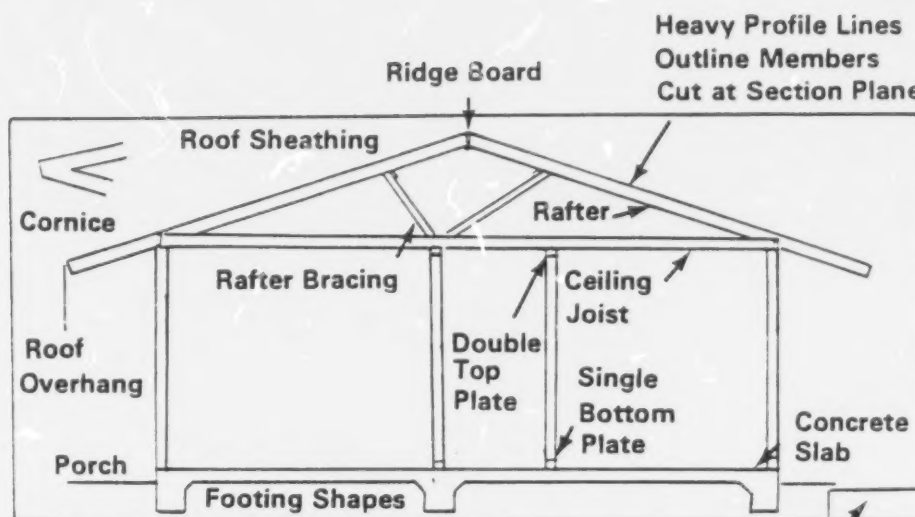
Typical Wall Section

Scale $\frac{3}{4}" = 1'-0"$

DRAWING A WALL SECTION DETAIL

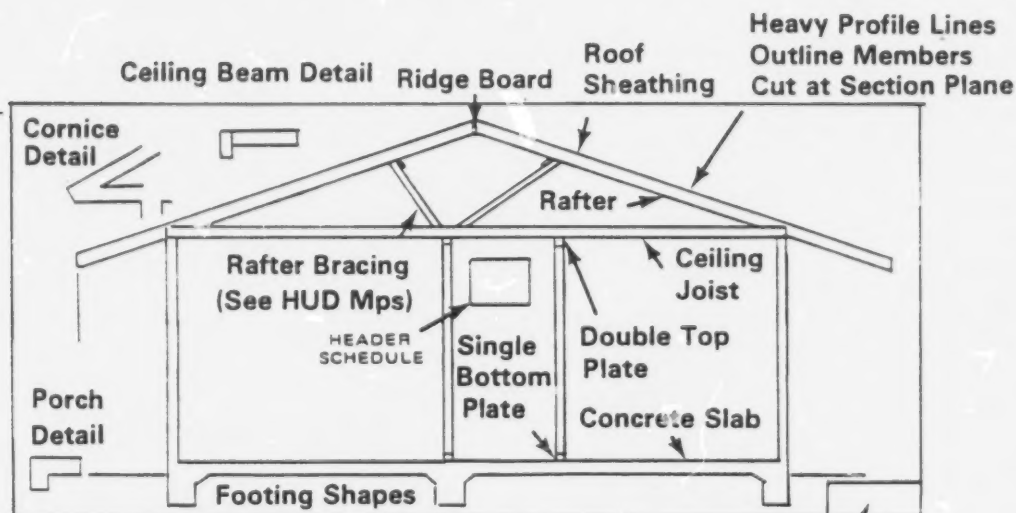


DRAWING A WALL SECTION DETAIL (continued)



Step 3 - Add Material Thickness, Detail, etc.

Title Block



Step 4 - Add Other Detail Sections

Title Block

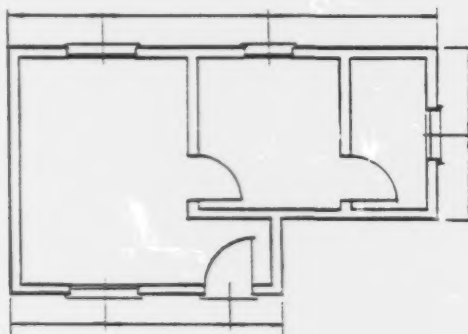
DIMENSION A FLOOR PLAN

Directions: Dimension the floor plan in the problem on vellum with $1/4" = 1'-0"$ scale. Use the procedure in the example to aid in placement of dimension and extension lines.

Example:

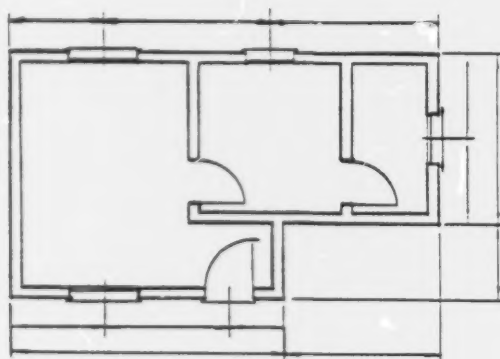
1. Place a line of dimensions on every outside wall containing a window or door at least $3/8"$ beyond the farthest projection. (Figure 1)

FIGURE 1



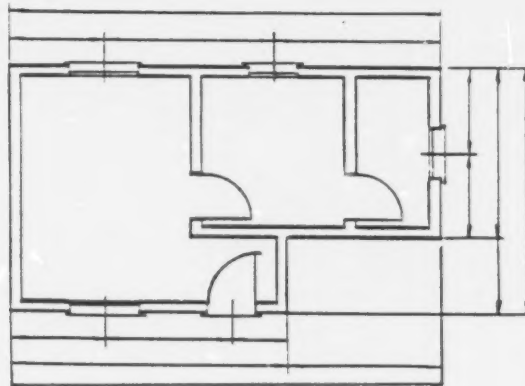
2. Place a second line of dimensions on every wall containing offsets to provide subtotal dimensions for each wall. (Figure 2)

FIGURE 2



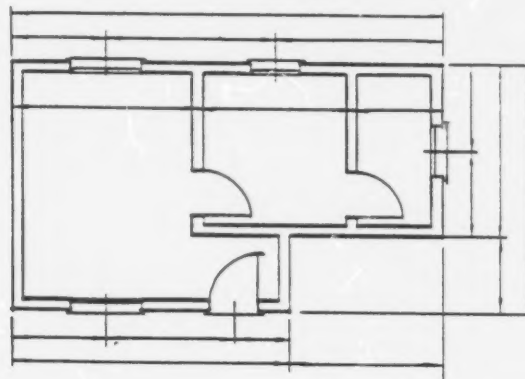
3. Place overall dimension lines and check that the subtotal dimensions equal the overall dimension. (Figure 3)

FIGURE 3



4. Place lines of interior dimensions to locate partitions and interior features. (Figure 4)

FIGURE 4



5. Place additional required notes and schedule reference symbols to complete the drawing.

Problem: Dimension one of the floor plans that you drew in Unit I, "Introduction to Architectural Drawings."

DIMENSION AN ELEVATION

Directions: Dimension the elevation that you drew in AS 1.3 of Unit 1, "Introduction to Architectural Drawings."

DRAW A WALL SECTION DETAIL

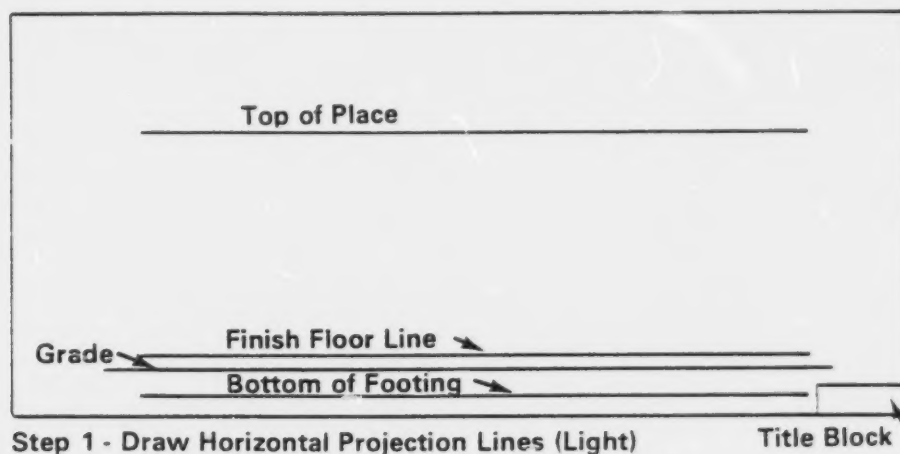
Directions: Draw a wall section detail using the procedure in the following example. Building sections are views taken through the structure at points which will best show the structural parts of the building. Sections are taken vertically, as with a typical wall section, or horizontally, as with a floor plan. Often, when the building is complex, several sections may be needed. The procedure in the example is for drawing a typical transverse section. Several other details are added.

Example:

NOTE: Consult manufacturers' catalogs for all information concerning the sizing and spacing of all building members, all materials used in structure, design sketches, examples of scale drawings of a typical wall section, and examples of sections of all component parts to be used in the section.

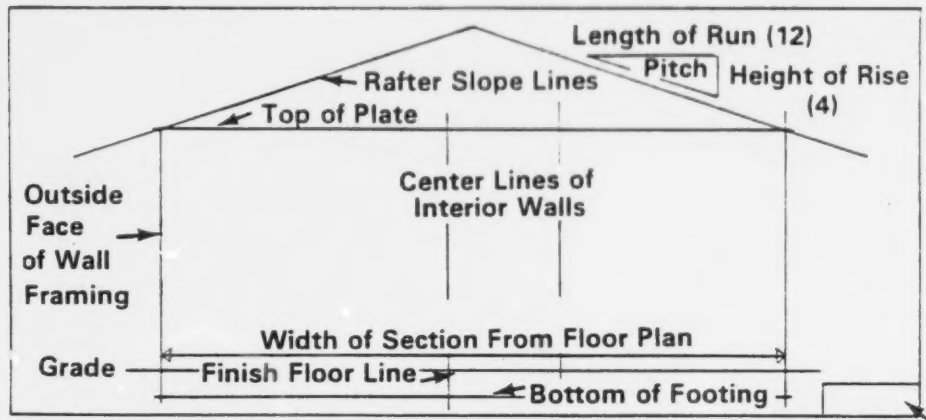
1. Using scale $3/4" = 1'-0"$, construct grade, top and bottom of footing, height of plate, and finish floor. (Figure 1)

FIGURE 1



- Construct outside walls, width of footings, thickness of walls, slope, and thickness of roof.

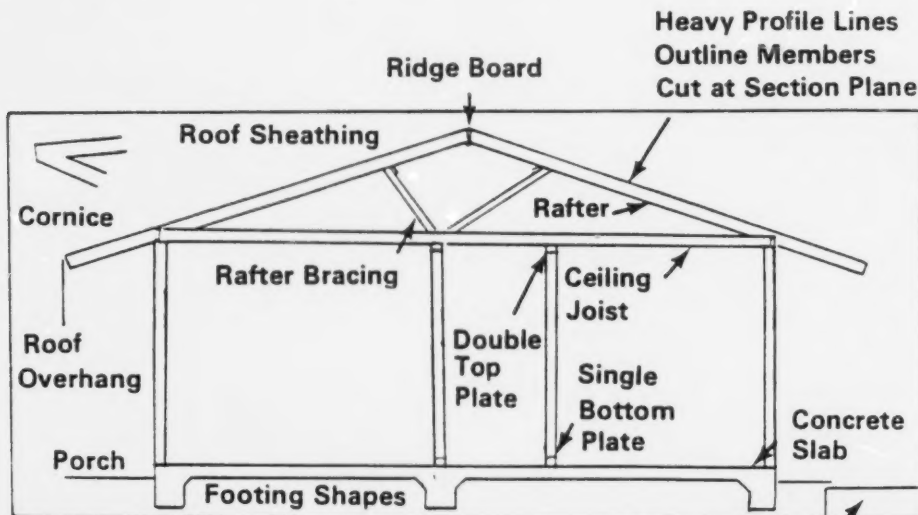
FIGURE 2



Step 2 - Draw Vertical Projection Lines (Light)

- Construct outlines of footings, walls, joists, rafters, and other related footing, cornice, beam, window, and door details; add material thickness to details. (Figure 3)

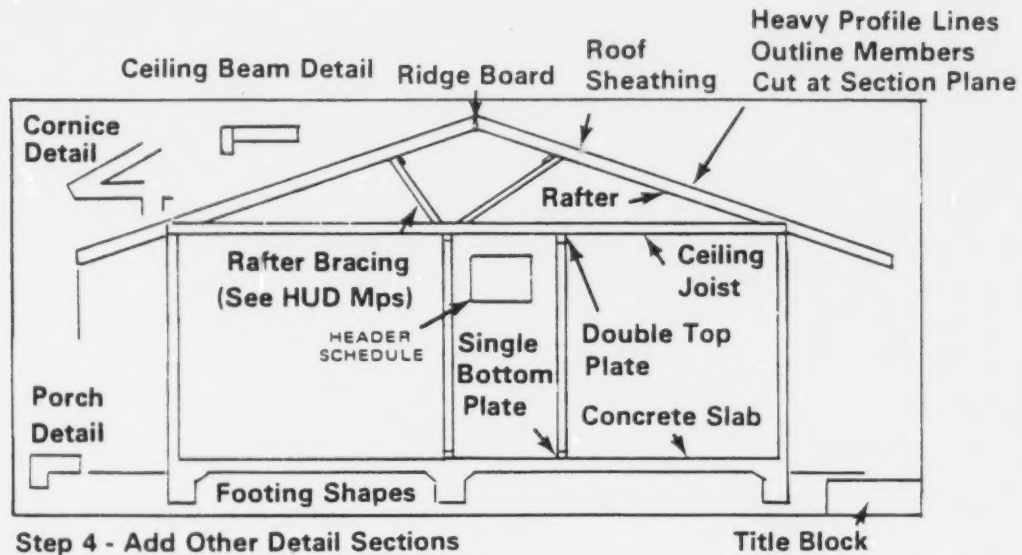
FIGURE 3



Step 3 - Add Material Thickness, Detail, etc.

4. Erase construction lines, add dimensions, add notes or call outs for all materials and structural parts, darken in lines, add shading to concrete, and complete titles for all details. (Figure 4)

FIGURE 4



Problem: Construct a typical wall section detail on C-size media using proper scale for a residential home as assigned by instructor.

NOTE: This may be for your design project or another residence.

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT III: DIMENSIONING ARCHITECTURAL DRAWINGS
ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT III: DIMENSIONING ARCHITECTURAL DRAWINGS

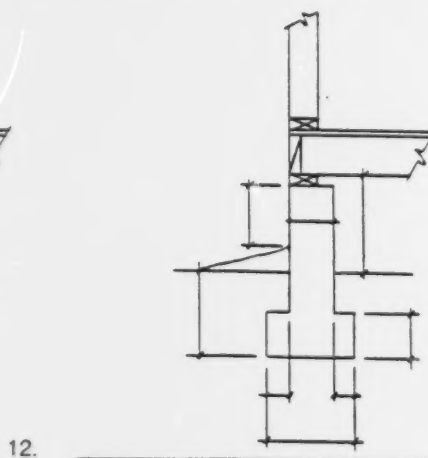
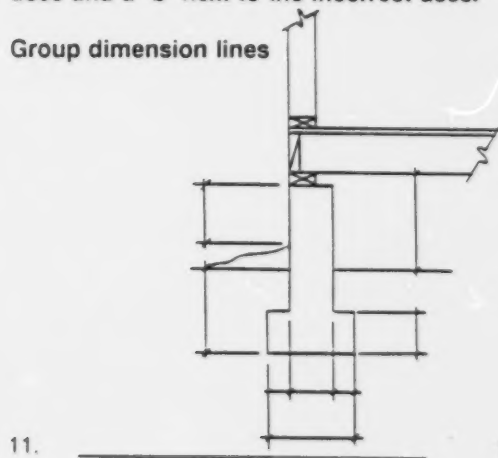
UNIT TEST

Match the terms on the right with the correct definitions.

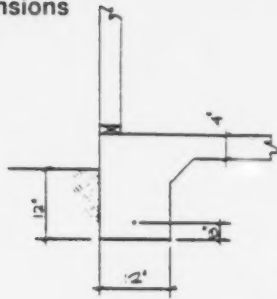
- | | |
|---|-----------------------|
| ___ 1. Recording the actual size of the building and its many parts accurately on a drawing | a. Dimensioning |
| ___ 2. Dimension that locates a feature on an object | b. Size dimension |
| ___ 3. Dimension which tells how large or small an object is | c. Special notes |
| ___ 4. Dimension for a small part | d. Modular system |
| ___ 5. Dimension showing the total length of an object | e. Location dimension |
| ___ 6. Notes which give the name of kinds of materials or operations | ab. General notes |
| ___ 7. Notes which give procedures or information, usually placed at bottom or right hand of sheet | ac. Detail dimension |
| ___ 8. A standard unit of measurement | ad. Call out |
| ___ 9. Where most materials are equal in size to an established module or a multiple of that module | ae. Module |
| ___ 10. Specific note that is directed to a specific point on a drawing by the use of a leader | bc. Overall dimension |

Distinguish between correct and incorrect uses of dimensioning by placing an "a" next to the correct uses and a "b" next to the incorrect uses.

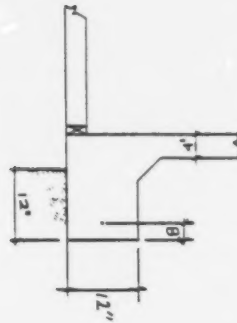
Group dimension lines



Location dimensions

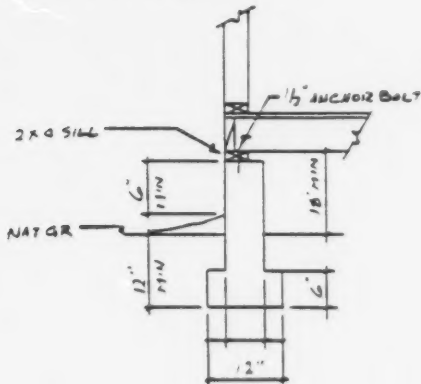


13. _____

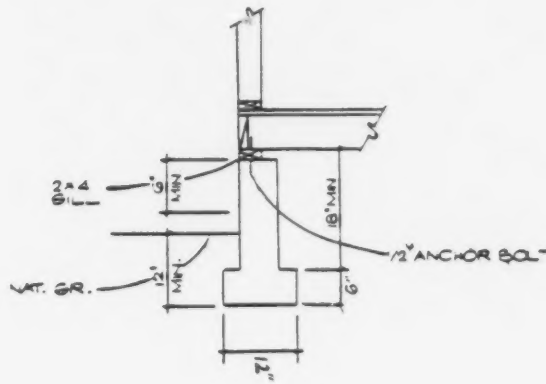


14. _____

Crossing dimension lines



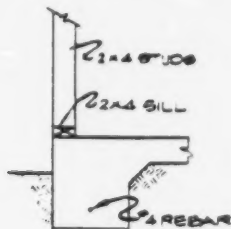
15. _____



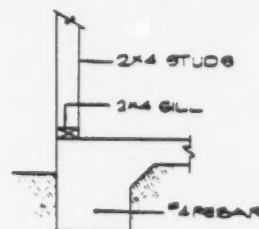
16. _____

Leaders

NOTE: Place an "a" beside the illustration which is best, and a "b" beside the worst illustration.

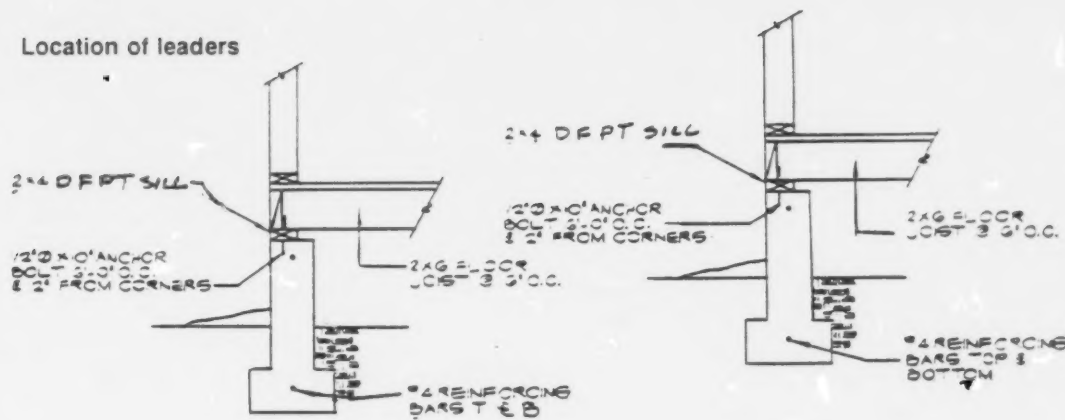


17. _____



18. _____

Location of leaders



19.

20.

Select true statements concerning general dimensioning rules by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- ☐ 21. Everything does not need to be dimensioned the actual size.
- ☐ 22. Dimensions should not be crowded; keep dimensions at least 3/8" from the drawing and from each other.
- ☐ 23. A broken dimension line should be used and the dimension should be placed below it.
- ☐ 24. Distances less than one foot are given in inches.
- ☐ 25. Dimensions are placed on a drawing so they can be read from the left side of the drawing.
- ☐ 26. Dimension lines are drawn heavier than visible lines used to draw the views.
- ☐ 27. Extension lines should always cross dimension lines.
- ☐ 28. Extension lines may not cross each other.
- ☐ 29. Whenever possible, line up a series of dimensions.
- ☐ 30. Place the shortest dimensions near the object; the overall dimension should be on the outside.
- ☐ 31. When a space to be dimensioned is too small to receive the figures, delete the figures.
- ☐ 32. Dimension numerals and notes are lettered 1" high.

Select true statements concerning floor plan dimensioning by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- ☐ 33. Projections and offsets are not dimensioned.
- ☐ 34. Cumulative dimensions should be added to see that their total equals the overall dimension.
- ☐ 35. Identify fixtures and built-in items which cannot be clearly drawn, such as a clothes chute, dishwasher, or garbage disposal.

- ☐ 36. The size and direction of ceiling joists and floor joists can be shown by symbol and noted.
- ☐ 37. Rooms are not identified by name.
- ☐ 38. The size and depth of the fireplace opening are commonly shown, and hearth material is indicated.
- ☐ 39. The width and length of each room are given, and interior walls are located by dimensioning to the center line of wall.
- ☐ 40. When dimensioning an exterior frame wall, the dimension never extends over the stud.
- ☐ 41. When dimensioning an exterior masonry veneer wall, 12" is allowed beyond the face of the wall.
- ☐ 42. Doors and windows in solid masonry walls are usually dimensioned to the masonry sides of the opening.
- ☐ 43. Door and window sizes must always be noted directly on the floor plan.
- ☐ 44. Floor material does not need to be indicated on the plan.
- ☐ 45. Areas to be cut or filled should not be noted.
- ☐ 46. Materials in concrete floors do not have to be noted.

Select true statements concerning elevation dimensioning by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- ☐ 47. The ceiling line and finished floor line are indicated and the total distance between these is shown.
- ☐ 48. Roof slope is indicated by the symbol ϕ .
- ☐ 49. The overhang of the roof at the eaves is indicated on a separate drawing.
- ☐ 50. The finished grade is indicated by a note.
- ☐ 51. Window sizes and door sizes are sometimes lettered below the door or window, but the door and window schedule is preferred.

Select true statements concerning detail and wall section dimensioning by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- ☐ 52. The dimensions, material, and location of all members in a wall section are specified.
- ☐ 53. Draw materials to their **actual** sizes.
- ☐ 54. Finished floor to finished ceiling distance is not specified.
- ☐ 55. Cabinets and other built-ins require extensive, complete dimensions.

- ___ 56. Fireplace details require only overall dimensions.
- ___ 57. Stair details should have tread and riser indicated and total stair rise and run noted.

Arrange in order the steps for drawing a wall section detail by placing the correct sequence letters in the appropriate blanks.

- ___ 58. Add material thickness and primary detail. a = 1
- ___ 59. Add other detail sections. b = 2
- ___ 60. Draw vertical projection lines lightly. c = 3
- ___ 61. Draw horizontal projection lines lightly. d = 4

62. Complete the following chart of dimensioning abbreviations.

- | | | | |
|------------|-------|--------------------|-------|
| a. _____ | A/C | f. _____ | HW |
| b. Bedroom | _____ | g. _____ | LR |
| c. Ceiling | _____ | h. Reinforcing bar | _____ |
| d. _____ | CL | i. Weatherproof | _____ |
| e. _____ | FPL | | |

63. Complete the following table for drawing wall thicknesses.

	Actual Size	Drawn Size
Wood frame walls		
1) Interior	_____	5"
2) Interior (with vent pipe plumbing)	6 1/2"	_____
3) _____	5"	6"
Brick veneer on frame	_____	10"
Concrete masonry unit walls	4", 6", 8", or 12"	_____

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT III: DIMENSIONING ARCHITECTURAL DRAWINGS

ANSWERS TO UNIT TEST

- | | | | | | |
|-----|----|--------------|-----|------------------|-------|
| 1. | a | (K, 2 and 4) | 46. | b | (K-2) |
| 2. | e | (K, 2 and 4) | 47. | a | (K-2) |
| 3. | b | (K, 2 and 4) | 48. | b | (K-2) |
| 4. | ac | (K, 2 and 4) | 49. | b | (K-2) |
| 5. | bc | (K, 2 and 4) | 50. | a | (K-2) |
| 6. | c | (K, 2 and 4) | 51. | a | (K-2) |
| 7. | ab | (K, 2 and 4) | 52. | a | (K-4) |
| 8. | ae | (K, 2 and 4) | 53. | a | (K-4) |
| 9. | d | (K, 2 and 4) | 54. | b | (K-4) |
| 10. | ad | (K, 2 and 4) | 55. | b | (K-4) |
| 11. | a | (K, 4) | 56. | b | (K-4) |
| 12. | b | (K, 4) | 57. | a | (K-4) |
| 13. | b | (K, 4) | 58. | c | (K-4) |
| 14. | a | (K, 4) | 59. | d | (K-4) |
| 15. | a | (K, 4) | 60. | b | (K-4) |
| 16. | b | (K, 4) | 61. | a | (K-4) |
| 17. | b | (K, 4) | | | |
| 18. | a | (K, 4) | 62. | (K, 2 and 4) | |
| 19. | a | (K, 4) | a. | Air conditioning | |
| 20. | b | (K, 4) | b. | BR | |
| 21. | b | (K, 2 and 4) | c. | CLG | |
| 22. | a | (K, 2 and 4) | d. | Closet | |
| 23. | b | (K, 2 and 4) | e. | Fireplace | |
| 24. | a | (K, 2 and 4) | f. | Hot water | |
| 25. | b | (K, 2 and 4) | g. | Living room | |
| 26. | b | (K, 2 and 4) | h. | REBAR | |
| 27. | b | (K, 2 and 4) | i. | WP | |
| 28. | b | (K, 2 and 4) | | | |
| 29. | a | (K, 2 and 4) | | | |
| 30. | a | (K, 2 and 4) | | | |
| 31. | b | (K, 2 and 4) | | | |
| 32. | b | (K, 2 and 4) | | | |
| 33. | b | (K-2) | | | |
| 34. | a | (K-2) | | | |
| 35. | a | (K-2) | | | |
| 36. | a | (K-2) | | | |
| 37. | b | (K-2) | | | |
| 38. | a | (K-2) | | | |
| 39. | a | (K-2) | | | |
| 40. | b | (K-2) | | | |
| 41. | b | (K-2) | | | |
| 42. | a | (K-2) | | | |
| 43. | b | (K-2) | | | |
| 44. | b | (K-2) | | | |
| 45. | b | (K-2) | | | |

63. (K, 2 and 4)

	Actual Size	Drawn Size
Wood frame walls		
1) Interior	<u>4 1/2"</u>	5"
2) Interior (with vent pipe plumbing)	6 1/2"	<u>6-8"</u>
3) <u>Exterior</u>	5"	6"
Brick veneer on frame	<u>9"</u>	10"
Concrete masonry unit walls	4", 6", 8", or 12"	<u>4", 6", 8" or 12"</u>

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT IV: ELECTRICAL DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to name parts of an electrical service entrance installation and match wiring devices and cables with their applications. The student should also be able to answer questions using the National Electric Code and locate electrical symbols on a floor plan. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

- 4.1 Match terms related to electrical with the correct definitions.
- 4.2 Distinguish between types of lighting dispersement.
- 4.3 Name parts of electrical service entrance installation.
- 4.4 Distinguish between types of residential branch circuits.
- 4.5 Match wiring devices with common residential applications.
- 4.6 Match types of cables with common applications.
- 4.7 State conductor letter designations for installation conditions.
- 4.8 Select true statements concerning designing an electrical system for a residence.
- 4.9 Match electrical floor plan symbols with the correct names.
- 4.10 Name overcurrent circuit safety devices.
- 4.11 Demonstrate the ability to:
 - a. Answer questions related to residential wiring practices using the NEC. (AS 4.1)
 - b. Interpret conduit fill tables using the NEC. (AS 4.2)
 - c. Locate allowable ampacities for various conductors using the NEC. (AS 4.3)
 - d. Calculate service size and minimum number of circuits. (AS 4.4)
 - e. Locate receptacle, switch, and lighting outlets. (AS 4.5)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT IV: ELECTRICAL DRAWINGS

CONTENTS OF THIS UNIT

- A. Objective sheet
- B. References
- C. Notes to the instructor
- D. Lesson plan
 - 1. **Lesson 1: Electrical Drawings** 149
 - a. Information sheet
 - b. Transparency masters
 - TM 4.1: Three Formulas from Ohm's Law
 - TM 4.2: Service Entrance Installation
 - TM 4.3: Typical Service Panel Arrangement
 - TM 4.4: Typical Distribution Panel Schematic
 - TM 4.5: Wiring Devices
 - TM 4.6: Wiring Devices (continued)
 - TM 4.7: Wiring Devices (continued)
 - TM 4.8: Wiring Devices (continued)
 - TM 4.9: Wiring Devices (continued)
 - TM 4.10: Low Voltage System
 - TM 4.11: Electrical Floor Plan
 - c. Assignment sheets
 - AS 4.1: Answer Questions Related to Residential Wiring Practices Using the NEC
 - AS 4.2: Interpret Conduit Fill Tables Using the NEC
 - AS 4.3: Locate Allowable Ampacities for Various Conductors Using the NEC
 - AS 4.4: Calculate Service Size and Minimum Number of Circuits
 - AS 4.5: Locate Receptacle, Switch, and Lighting Outlets
 - d. Answer to assignment sheets
- E. Unit test
- F. Answers to unit test

REFERENCES

- A. Gebert, Kenneth L. National Electrical Code Blueprint Reading. Chicago, IL: American Technical Society, 1977.
- B. HUD Minimum Property Standards. Washington, D.C.: U.S. Department of Housing and Urban Development, 1973.
- C. National Electrical Code. Boston: National Fire Protection Association, 1975.
- D. Spence, William P. Architecture Design - Engineering - Drawing. Bloomington, IL: McKnight Publishing Co., 1979.
- E. Stegman, George K. and Harry J. Stegman. Architectural Drafting. Chicago, IL: American Technical Society, 1974.
- F. Willis Charles D. Blueprint Reading for Commercial Construction. Albany, NY: Delmar Publishers/Litton Educational Publishing, Inc., 1979.

NOTES TO THE INSTRUCTOR

- A. Suggested approaches to teaching this unit:
 - 1. Provide examples of residential and commercial electrical floor plans.
 - 2. Provide electrical supply catalogs and the current National Electric Code for use in the assignment sheets. The NEC may be obtained in soft or hardbound copies from the following: National Fire Protection Association, Battery March, Quincy, Mass. 02269.

NOTE: The Code is revised every three years.

- 3. Demonstrate the use of floor plan templates or electrical utility company's advertising type templates for drawing electrical symbols.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT IV: ELECTRICAL DRAWINGS

LESSON 1: ELECTRICAL DRAWINGS

I. Terms and definitions

- A. **American wire gauge (AWG)**--a standard size classification for copper and aluminum wires up to 0000
- B. **Ampacity**--current-carrying capacity of electric conductors expressed in amperes
- C. **Ampere (I)**--unit of measure of the intensity of the flow or current of electricity
- D. **Bare conductor**--a conductor having no covering or electrical insulation
- E. **Branch circuit**--the circuit conductors between the final overcurrent device protecting the circuit and the outlet(s)
- F. **Busway**--a preassembled metal box system used to distribute high-current loads
- G. **Circuit breaker**--a switching device that automatically opens a circuit when the circuit has been overloaded
- H. **Circuit**--a complete path for current to flow from the source through the load and back to the source
- I. **Conductor**--material which permits the free flow of electrons
- J. **Conduit**--a channel or pipe, made of metal or plastic, in which conductors are run
- K. **Covered conductor**--a conductor encased with a material not recognized by the NEC as insulation
- L. **Distribution panel**--the electrical enclosure that contains the overcurrent protection for circuits and connects to the service conductor

NOTE: This is sometimes called a load center.

- M. **Electrical metal tubing (EMT)**--thin wall metal raceway of circular cross sections with integral or associated couplings, connectors, and fittings approved for the installation of electrical conductors

NOTE: This is sometimes called thin wall conduit.

- N. **Flexible metal conduit**--spiral metal raceway designed for flexible installation with a circular cross section and integral or associated couplings, connectors, and fittings approved for the installation of electrical conductors
- O. **Fuse**--overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it

P. **Ground wire**--a wire connecting the circuit or equipment to the earth or water pipes to minimize injuries from shock

Q. **Ground-fault circuit interrupter**--a device that is sensitive to very low levels of current leakage to ground

NOTE: This is commonly installed in the bath or kitchen, or outside near the swimming pool.

R. **Grounded conductor**--a circuit conductor that is intentionally connected to the earth or some conductor that serves in place of the earth

S. **Grounding conductor**--connects equipment or wiring circuit grounded conductor to a grounding electrode

T. **Insulated conductor**--a conductor encased with a material recognized by the NEC as insulation

U. **Insulator**--material which does not permit the free flow of electrons

V. **Interlocked armor cable (BX)**--a flexible armor-shielded cable that has two or more conductors within the casing

W. **Kilowatt**--one thousand watts

X. **Knob and tube wiring**--wiring method using knobs, tubes, and flexible nonmetallic tubing for protection and support of single insulated conductors in walls and ceilings of buildings

Y. **Liquid-tight flexible metal conduit**--flexible metal conduit with an outer liquid-tight, nonmetallic, sunlight-resistant jacket

Z. **Low voltage (residential remote control and signal circuits)**--wiring of less than 50 volts originating at a transformer

AA. **National Electric Code (NEC)**--a basic minimum standard covering the installation of electrical equipment to safeguard persons and property

NOTE: Hereafter in this unit, this will be referred to as the NEC or the Code.

BB. **Nonmetallic sheathed cable**--two or more wires enclosed in a flexible plastic case

NOTE: This is sometimes called Romex.

CC. **Ohm (R)**--unit of measure of the resistance to the flow of electricity

DD. **Ohm's Law**--a law which can be used for calculating wattage, voltage, and amperage for circuits (TM 4.1)

EE. **Outlet**--a point on the wiring system at which current is taken to supply utilization equipment

FF. **Raceway**--a metal-enclosed box that is placed on the floor prior to placement of concrete floor to allow for various outlets

GG. **Receptacle outlet**--an outlet where one or more receptacles is installed

- HH. **Receptacle**--contact device installed at the outlet for the connection of a single attachment plug
- II. **Rigid conduit**--similar to electrical metal tubing except that the pipe is heavier and is threaded
- JJ. **Service drop**--the overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service entrance conductors at the building or other structure
- KK. **Service entrance**--the conductors from utility pole and service head which bring the current to the building through the meter to the distribution panel (TM 4.2)
- LL. **Thousand circular mils (MCM)**--the standard size classification for conductors larger than 0000
- MM. **Volt (E)**--unit of measure of electrical pressure
- NN. **Watt (W)**--unit of measure of electrical power

II. Types of lighting dispersement

- A. Direct--



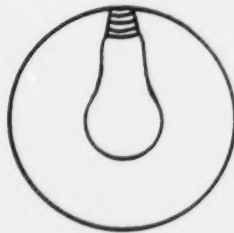
- B. Indirect--



- C. Combination--



D. Diffused--



III. Parts of electrical service entrance installation (TMs 4.2, 4.3, and 4.4)

A. Electrical service line

NOTE: This is the service drop.

B. Meter socket trough

NOTE: Meter is usually supplied by the utility company.

C. Main disconnect switch (circuit breaker or fused)

D. Distribution panel

E. Weatherhead assembly

NOTE: This is only for above ground service.

IV. Types of residential branch circuits

A. General purpose circuit--15 or 20 amp circuit used for lighting and small appliances

B. Appliance circuit--20 amp circuit used for one or more outlets to which appliances are to be connected

C. Special purpose individual circuit--115/120 volt or 208/240 volt circuit used for one single outlet

Examples: Dryer, range-oven

V. Wiring devices and common residential applications (TMs 4.5-4.10)

A. Cable

1. Nonmetallic sheathed cable

NOTE: This is commonly called Romex.

a. General residential rough-in

b. Circuit extensions in existing building

NOTE: Nearly all the premises wiring in most new residential homes is done with NM cable.

2. Underground feeder and branch circuit cable (UF)--direct burial for yard lights or extensions

NOTE: Check local code for depth.

B. Concealed knob and tube wiring

1. Extensions of existing installations
2. Elsewhere by special permission

C. Rigid metal conduit

1. Through eave service masts to weatherhead
2. Underground circuit extension
3. In concrete walls, floors, or ceilings
4. Underground service riser

D. Electrical metallic tubing

1. Service raceway

NOTE: EMT is not suitable for installations going through an eave.

2. Protecting grounding conductor

E. Flexible metal conduit

NOTE: This is commonly called Greenfield.

1. Connecting recessed lighting fixtures
2. Enclosing motor leads

F. Liquid-tight flexible metal conduit

1. Connecting air conditioning condensers to disconnects
2. Enclosing motor leads needing protection from liquids and vapors

G. Raceways

1. Interior circuit extensions where concealed work is not necessary or is not possible
2. On interior concrete surfaces

H. Low voltage (Less than 50V)

1. Chime circuits
2. Intercom wiring

3. Thermostat circuits
4. Lighting remote control
5. Smoke detectors
6. Burglar alarms
- I. Rigid nonmetallic conduit or PVC (polyvinyl chloride)
 1. In locations subject to severe corrosive conditions
 2. In portions of dairies, laundries, canneries, or other wet locations
- VI. Types of cables and common applications
 - A. Nonmetallic sheathed cable (NM)
 1. Residential rough-in wiring in new construction
 2. Extensions of existing residential wiring and new remodel
 3. Feeders for sub-panels
 - B. Service entrance cable (SE)
 1. Service entrance conductors if used with rain tight head
 2. Branch circuit for ranges, cook tops, or clothes dryers
 - C. Low voltage cable
 1. Thermostat control circuits
 2. Bell or chime control circuits
 3. Low voltage lighting control circuits
 - D. Underground cable (UF)
 1. Underground circuits to remote lighting such as yard lights
 2. Branch circuits to out buildings such as garages
 - E. Underground service entrance cable (USE)--underground service supply
- VII. Conductor letter designations for installation conditions
 - A. T (Thermoplastic)--dry locations
 - B. TW (Thermoplastic moisture resistant)--dry and wet locations
 - C. THW (Thermoplastic moisture and heat resistant)--dry and wet locations where more heat resistant qualities are needed

- D. MTW (Moisture, heat, and oil-resistant thermoplastic)--dry and wet locations where oil may be present or where more heat resistant qualities are needed

NOTE. Refer to Code Table 310-13 for more applications.

VIII. Designing an electrical system for a residence (TM 4.11)

- A. A single pole switch controls a light or outlet from one location.
- B. A three-way switch is used to control a light from two locations.
- C. A four-way switch is used to control a light from three or more locations.
- D. Wall switches should be located on the door knob side of doors and on traffic side of arches.
- E. Switch locations should be placed so that a person can enter the house from any door and progress to any other part without being in the dark.
- F. Receptacle shall be placed so that no point on any usable wall space along the floor line is more than 6' from an outlet.
- G. Split-receptacle outlets should be used in living and dining areas in order not to limit the use of radios, clocks, or appliances.
- H. Master selector control for low voltage line control system should be in master bedroom.
- I. The dashed lines on electrical plans indicate which fixtures or outlets are controlled by switches; these lines do not indicate the actual wiring.

NOTE: The center line symbol can also be used. It is best to use an irregular curve when drawing these lines.

- J. Circuit wires, conduit, or cable runs are normally not indicated on residential electrical plans, but are used on commercial structures.
- K. Receptacle shall be placed on each side and within 3' to 4' from the center line of probable bed locations.
- L. One heavy duty, special purpose receptacle should be in each room if room air conditioners are recommended.
- M. A vapor proof luminaire should be installed in an enclosed shower stall.
- N. No cables other than low voltage shall have conductors smaller than #14 copper or #12 aluminum when used in residential wiring.
- O. Provide ceiling outlet in line with front edge of bath lavatory.
- P. Provide one receptacle near mirror in bath a minimum of 2' from water.
- Q. Provide one receptacle for each 4 linear feet of work surface frontage in kitchen.
- R. Place each receptacle on separate circuits in kitchen.

- S. Lighting fixtures below wall cabinets may have local switch control.
- T. Special purpose receptacles must be provided for dining, utility, and kitchen areas.
- U. Provide one lighting outlet for each closet where conditions make lighting necessary.
- V. Provide one receptacle for each 15 linear feet of hallway.
- W. Wall or ceiling outlets shall be installed to provide illumination of each stair flight.
- X. Provide lighting with wall switch for attic space.
- Y. Provide one receptacle in garage ceiling for door opener.

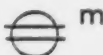
IX. Electrical floor plan symbols (TM 4.11)

- A. Single pole switch-- S
- B. Three-way switch-- S_3
- C. Four-way switch-- S_4
- D. Automatic door jamb switch-- S_J
- E. Dimmer switch-- S_D
- F. Switch with pilot light-- S_P
- G. Weatherproof switch-- S_{WP}
- H. Double pole switch-- S_2
- I. Switch for low voltage system-- $\underline{S}$
- J. Low voltage wire-- _____

- K. Low voltage master switch-- MS

- L. Relay equipped lighting outlet-- 

- M. Duplex receptacle outlet-- 

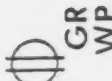
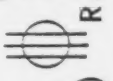
- N. Receptacle outlet other than duplex-- 

- O. Split wired receptacle outlet-- 

NOTE: Black indicates top receptacle outlet is hot at all times.

- P. Grounding type duplex receptacle outlet-- 

- Q. Weatherproof duplex outlet-- 

- R. Weatherproof grounding type duplex receptacle outlet-- 
- S. Range outlet-- 
- T. 220 volt outlet-- 
- U. Special--must be explained in the key to the symbols-- 
- V. Junction box-- 
- W. Lighting outlet-- 
- X. Square recessed light (size varies)-- 
- Y. Rectangular recessed light (size varies)-- 
- Z. Round recessed light (size varies)-- 
- AA. Fluorescent light-- 
- BB. Lampholder-- 
- CC. Lampholder with pull switch-- 
- NOTE: Check local code.**
- DD. Fan outlet-- 
- EE. Clock outlet-- 
- FF. Chime-- 
- GG. Bell-- 
- HH. Buzzer-- 
- II. Push button-- 
- JJ. Electric door opener-- 
- KK. Telephone-- 
- LL. T.V. antenna outlet-- 
- MM. Master power service panel-- 
- NN. Lighting distribution panel-- 

- X. Overcurrent circuit safety devices
 - A. Fuse
 - B. Circuit breaker
 - C. Ground-fault circuit interrupter

THREE FORMULAS FROM OHM'S LAW

$$W = \begin{array}{|c|c|} \hline & \\ \hline I & E \\ \hline \end{array} \quad \text{or } W = I \times E$$

or Watts = Amps x Volts

$$I = \begin{array}{|c|c|} \hline W & \\ \hline & E \\ \hline \end{array} \quad \text{or } I = W/E$$

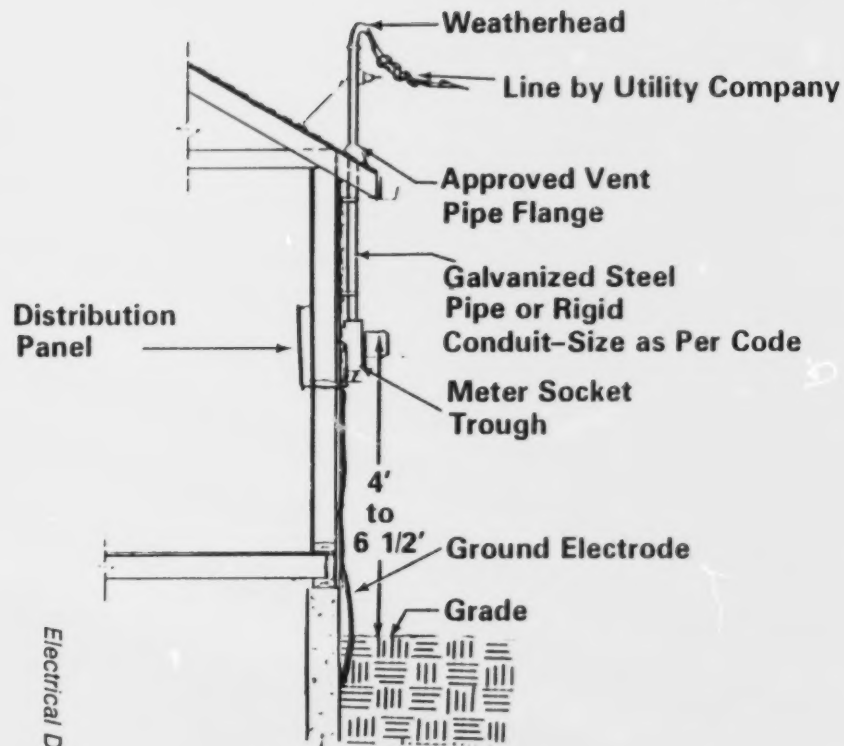
or Amps = Watts ÷ Volts

$$E = \begin{array}{|c|c|} \hline W & \\ \hline I & \\ \hline \end{array} \quad \text{or } E = W/I$$

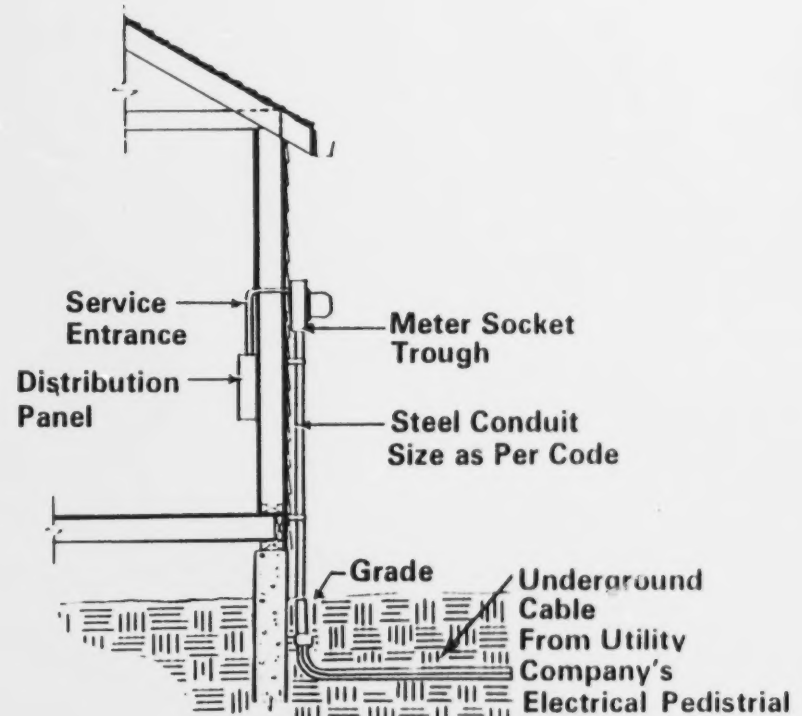
or Volts = Watts ÷ Amps

SERVICE ENTRANCE INSTALLATION

According to NEC

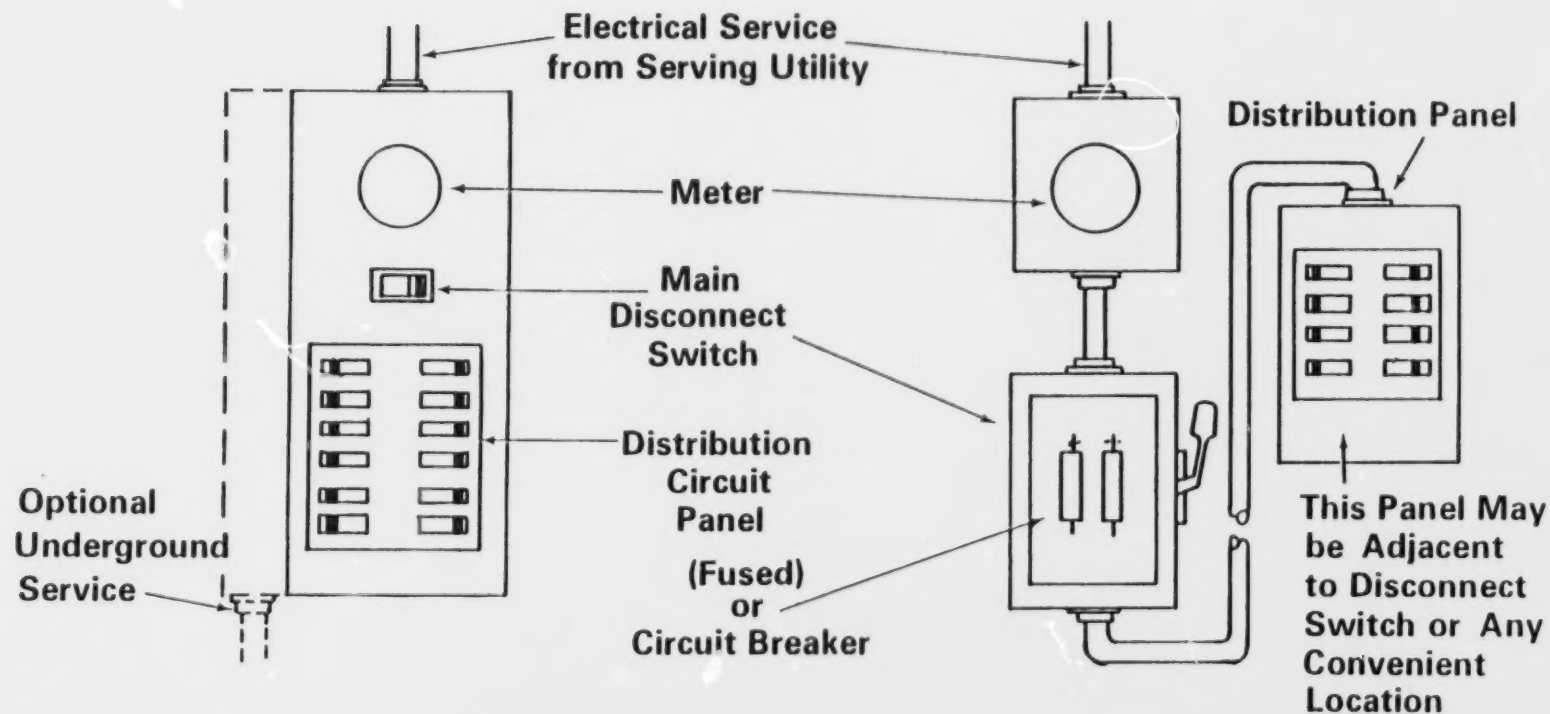


Above Ground Service



Underground Service

TYPICAL SERVICE PANEL ARRANGEMENT



One-Piece

NOTE: This is commonly used in light commercial.

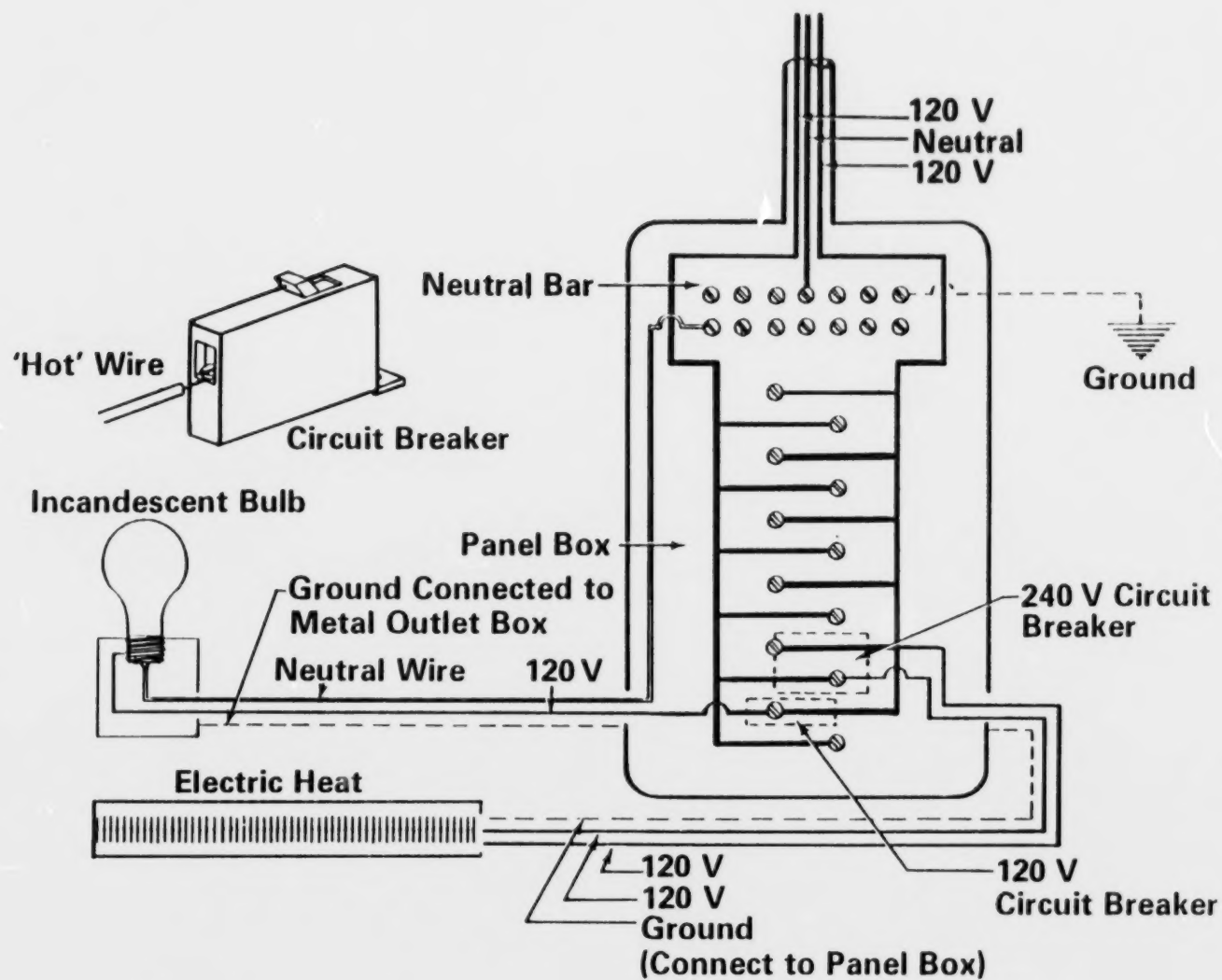
120

Built-Up System

NOTE: This is used for rural, mobile homes, or older residential buildings.

120

TYPICAL DISTRIBUTION PANEL SCHEMATIC



WIRING DEVICES

Nonmetallic Sheathed Cable

NOTE: This is commonly called romex.



NM Cable

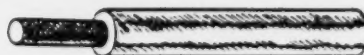


Staple



Connector

Concealed Knob and Tube



Insulated Conductor



Porcelain Tube



Knob



Braided Loom

WIRING DEVICES (continued)

Rigid Metal Conduit



Metal Conduit and Coupling



One-Hole Strap



Conduit Body

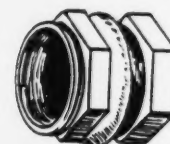
Electrical Metallic Conduit



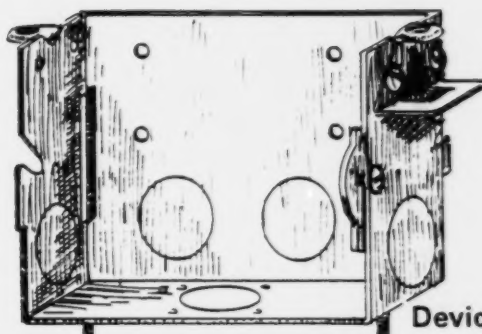
Electrical Metallic Conduit



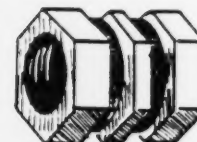
One-Hole Strap



EMT Coupling



Device Box for Conduit

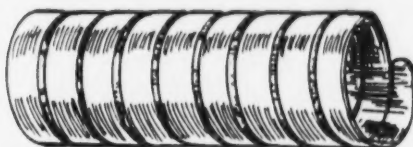


EMT Connector

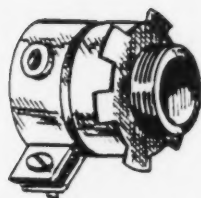
WIRING DEVICES (continued)

Flexible Metal Conduit

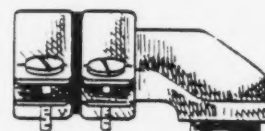
NOTE: This is commonly called greenfield.



Flexible Metal Conduit

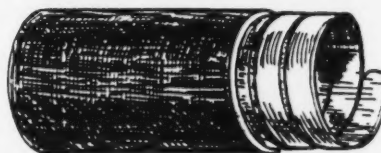


Straight Connector

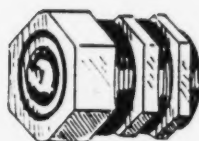


90° Connector

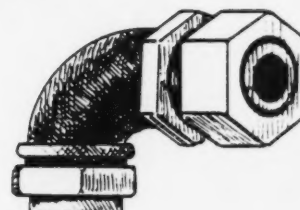
Liquid-Tight Flexible Metal Conduit



Liquid-Tight Flexible Metal Conduit



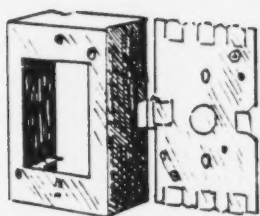
Liquid Tight Connector



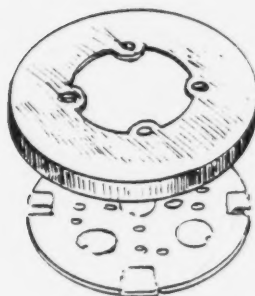
90° Liquid Tight Connector

WIRING DEVICES (continued)

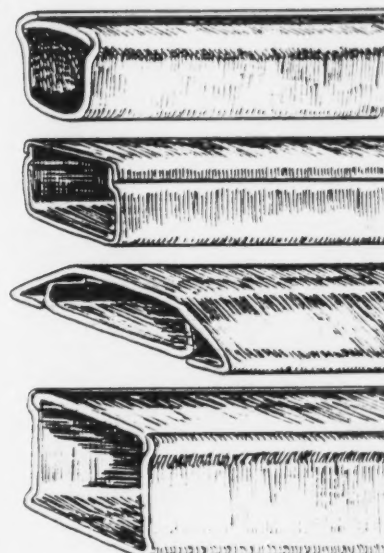
Surface Raceways



Surface Device Box

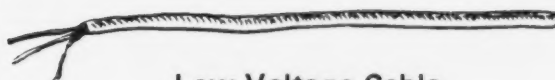


Surface Lighting Outlet

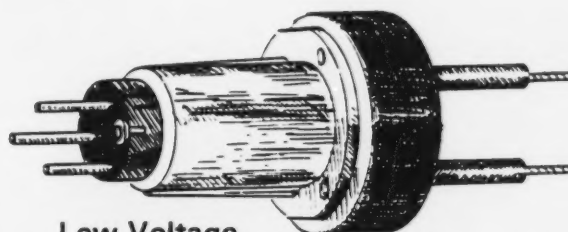


Surface Raceways

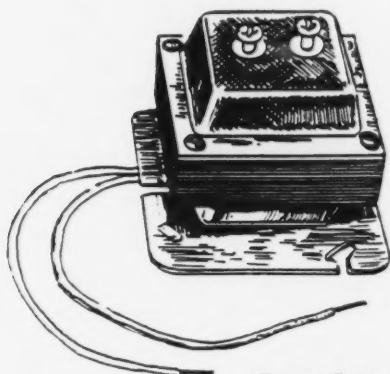
Low Voltage



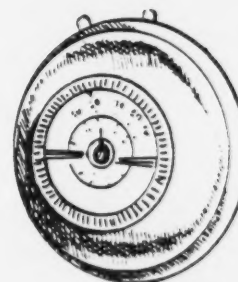
Low Voltage Cable



Low Voltage
Controlled Lighting Relay



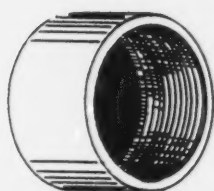
Transformer



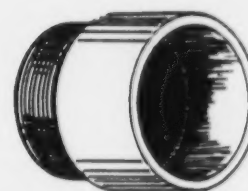
Thermostat

WIRING DEVICES (continued)

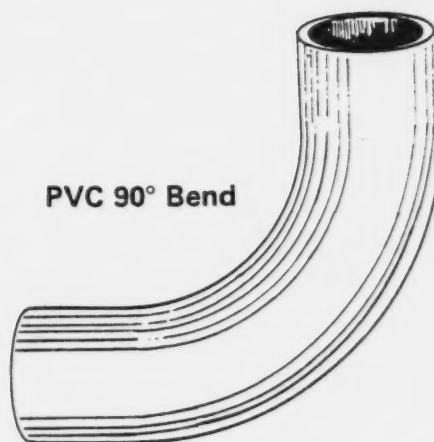
PVC (Polyvinyl Chloride)



**PVC to Threaded Adapter
(Female)**



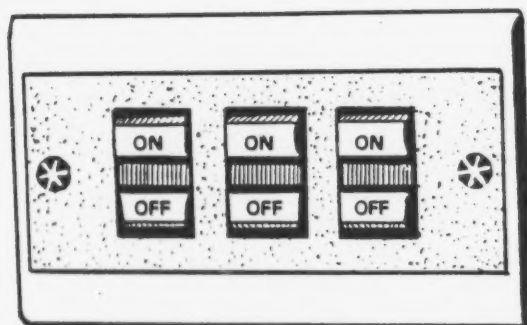
**PVC to Threaded Adapter
(Male)**



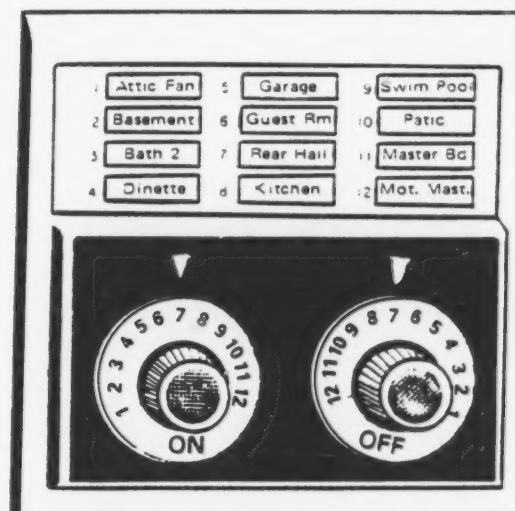
PVC 90° Bend

LOW VOLTAGE SYSTEM

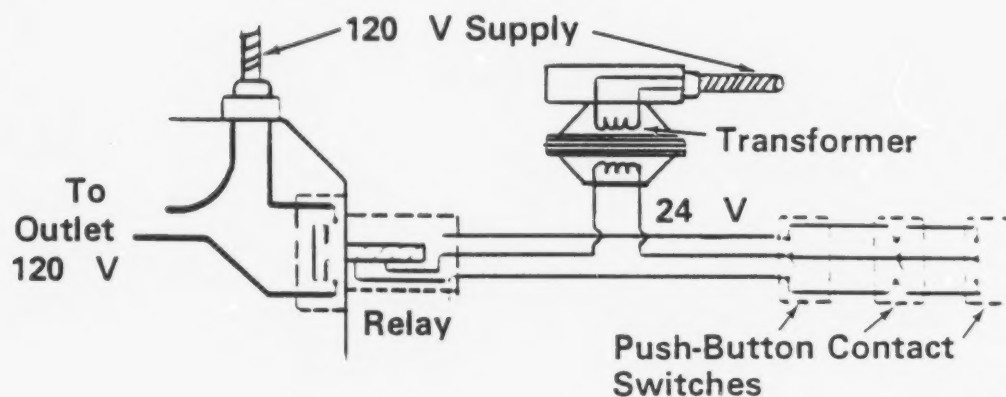
Remote Control for Line Voltage



Push-Button Switch

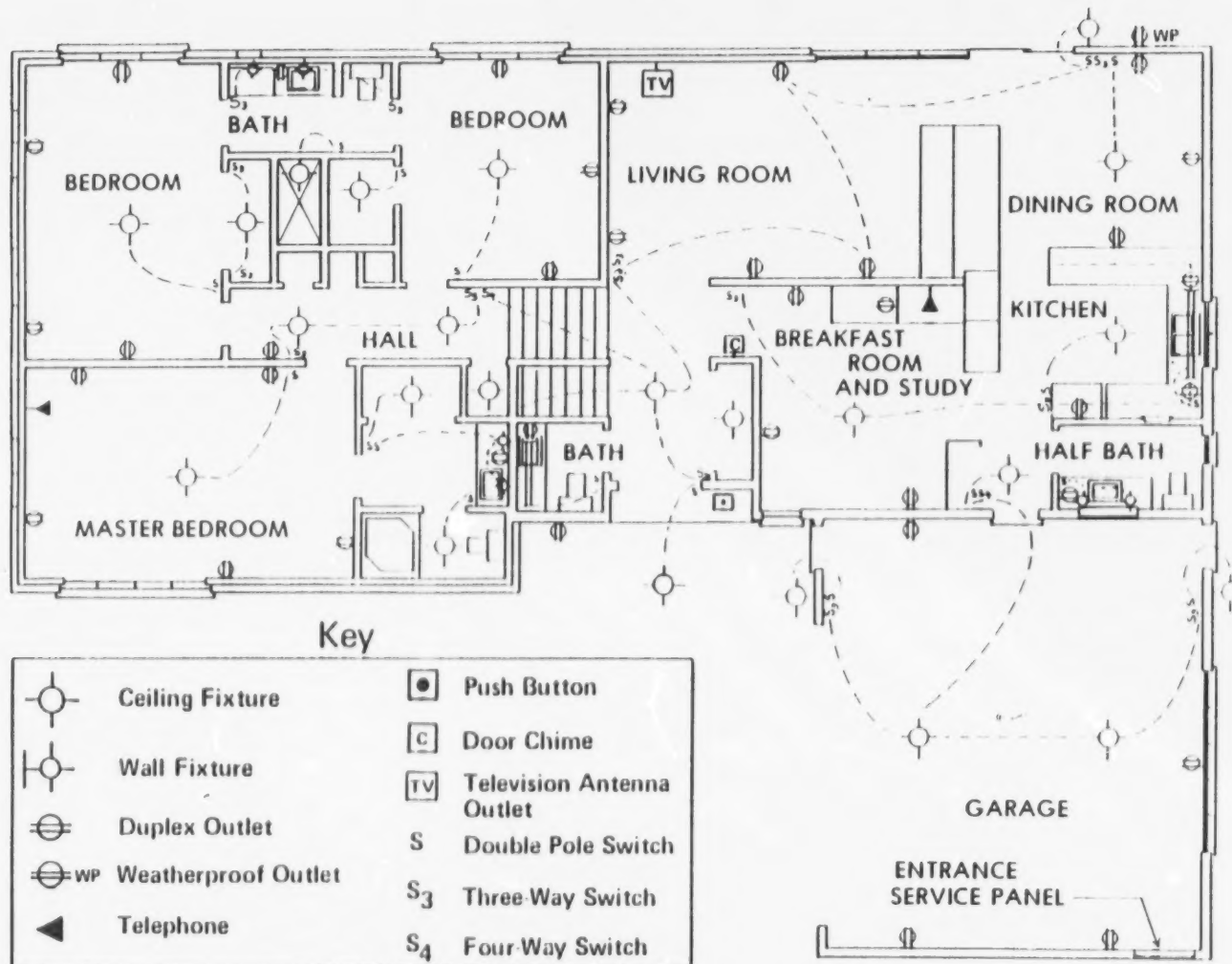


Master Selector Switch



Control Circuit

ELECTRICAL FLOOR PLAN



ANSWER QUESTIONS RELATED TO RESIDENTIAL WIRING PRACTICES USING THE NEC

Directions: Give article number and answer to the following problems. Steps used in the cross reference systems are listed in the procedure below.

Procedure:

1. Locate topics in the index.

NOTE: The index is in the back of the Code just before the appendix and is alphabetically arranged.

2. Note article and section of topic.
3. Find article listed in numerical order in the table of contents in the front of the Code.
4. Locate appropriate article and read across to find page number.

NOTE: Page numbers do not appear with the number "70" in them in the table of contents, but they will in the book proper.

5. Turn to page listed as chapter beginning.
6. Find section number needed in article.

Example: Are ground-fault circuit interrupters required on 20 amp construction receptacles?

- Step 1. Refer to index--"Ground-Fault Interrupters" is located and "Construction Sites" is listed.
- Step 2. Note listing of article.
- Step 3. Turn to table of contents and locate article number.
- Step 4. Read across to page number.
- Step 5. Find the page number for the article on branch circuits; turn to it.
- Step 6. Find section number by turning pages in article.

Answer: From the article on branch circuits, 20 amp receptacles on temporary poles do require ground-fault circuit interrupters.

Problems:

- A. Do boxes made of metal need to be corrosion resistant?

Answer:

B. What is the definition of "weatherproof"?

Answer:

C. Can a branch circuit used for lighting purposes and rated at 20 amps have a 12 amp dishwasher or other fixed appliance connected to it?

Answer:

INTERPRET CONDUIT FILL TABLES USING THE NEC

Directions: List the maximum number of conductors allowed in the following conduits. Use same procedure as listed on Assignment Sheet 4.1 to locate answers.

Problems:

A. 1/2" conduit

1. 14 TW _____

2. 10 TW _____

3. 6 TW _____

B. 3/4" conduit

1. 10 THWN _____

2. 4 THWN _____

C. 1" conduit

1. 6 TW _____

2. 2 TW _____

3. 6 THWN _____

D. 2" conduit

1. 4/0 THWN _____

2. 4/9 TW _____

LOCATE ALLOWABLE AMPACITIES FOR VARIOUS CONDUCTORS USING THE NEC

Directions: List the various ampacities for the conductors as listed.

Example: List the ampacities for the following conductors when used in a 3 conductor cable.

1. #12 TW copper _____
2. #6 TW copper _____

Answers: 1. 20 amps
2. 55 amps

Problems:

A. What is the allowable ampacity for the following single insulate copper conductors used in free air?

1. 14 TW _____
2. 1 TW _____
3. 1 THWN _____
4. 10 THW _____

B. What is the allowable ampacity for the following aluminum conductors when used in a 3 wire cable?

1. 10 TW _____
2. 12 TW _____
3. 1/0 TW _____
4. 6 TW _____

CALCULATE SERVICE SIZE AND MINIMUM NUMBER OF CIRCUITS

Directions: Using the standard code procedure listed below, calculate service size and minimum number of circuits on the following dwelling by filling in the blanks.

NOTE: The NEC gives an example of this problem in the chapter entitled "Tables and Examples."

Problem: Dwelling has a floor space of 2,100 square feet. It also has an 11 kw electric range.

Computed Load:

General lighting load

1. _____ sq. ft. X 3 watts per sq. ft. = 2. _____ watts

Minimum Number of Branch Circuits:

General lighting load: 3. _____ ÷ 115 = 4. _____ amperes ÷ 20 = 5. _____ or number of general lighting circuits

NOTE: This number always rounds to next whole number if a fraction appears.

Small appliance load: Two 2-wire 20 ampere circuits

Laundry load: One 2-wire 20 ampere circuit

NOTE: See Code for wattage.

Minimum Size Feeders Required:

Computed load

General lighting 6. _____ watts

Small appliance +3,000 watts

Laundry +1,500 watts

Total (without range) 7. _____ watts

3,000 watts at 100% 3,000 watts

8. _____ - 3,000 = _____ watts X 35% = 9. _____ watts

(Total w/o range)

Net computed load (without range) 10. _____ watts

Range load +8,000 watts

Net computed load (with range) 11. _____ watts

For 115/230 volt 2-wire system feeders, net computed load (with range) 12. _____ ÷ 230 = 13. _____ amperes

Net computed load exceeds 10 kw so service conductors shall be 100 amperes.

Reduced size neutral shall be permitted, usually two trade sizes smaller than the ungrounded conductors.

• **Feeder and Service Neutral**

Lighting and small appliance load (net without range) 14. _____ watts

Range load 8,000 watts at 70% + 5,600 watts

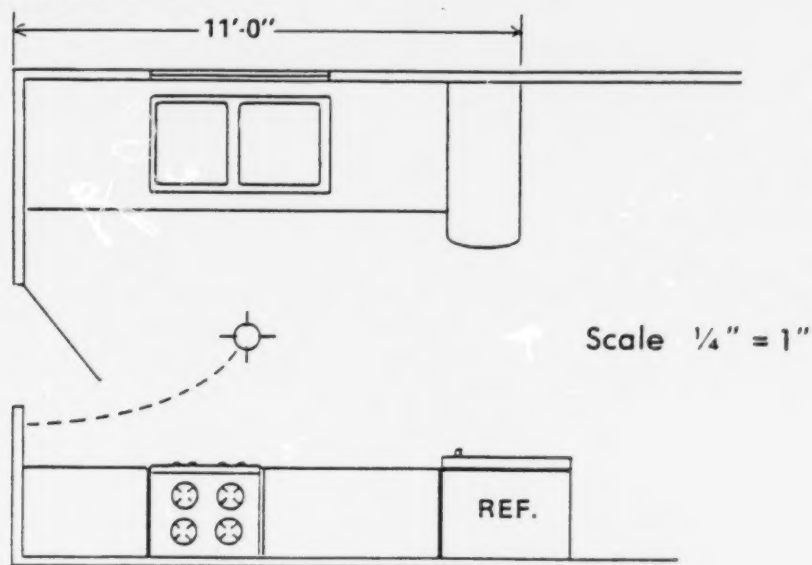
Total 15. _____ watts

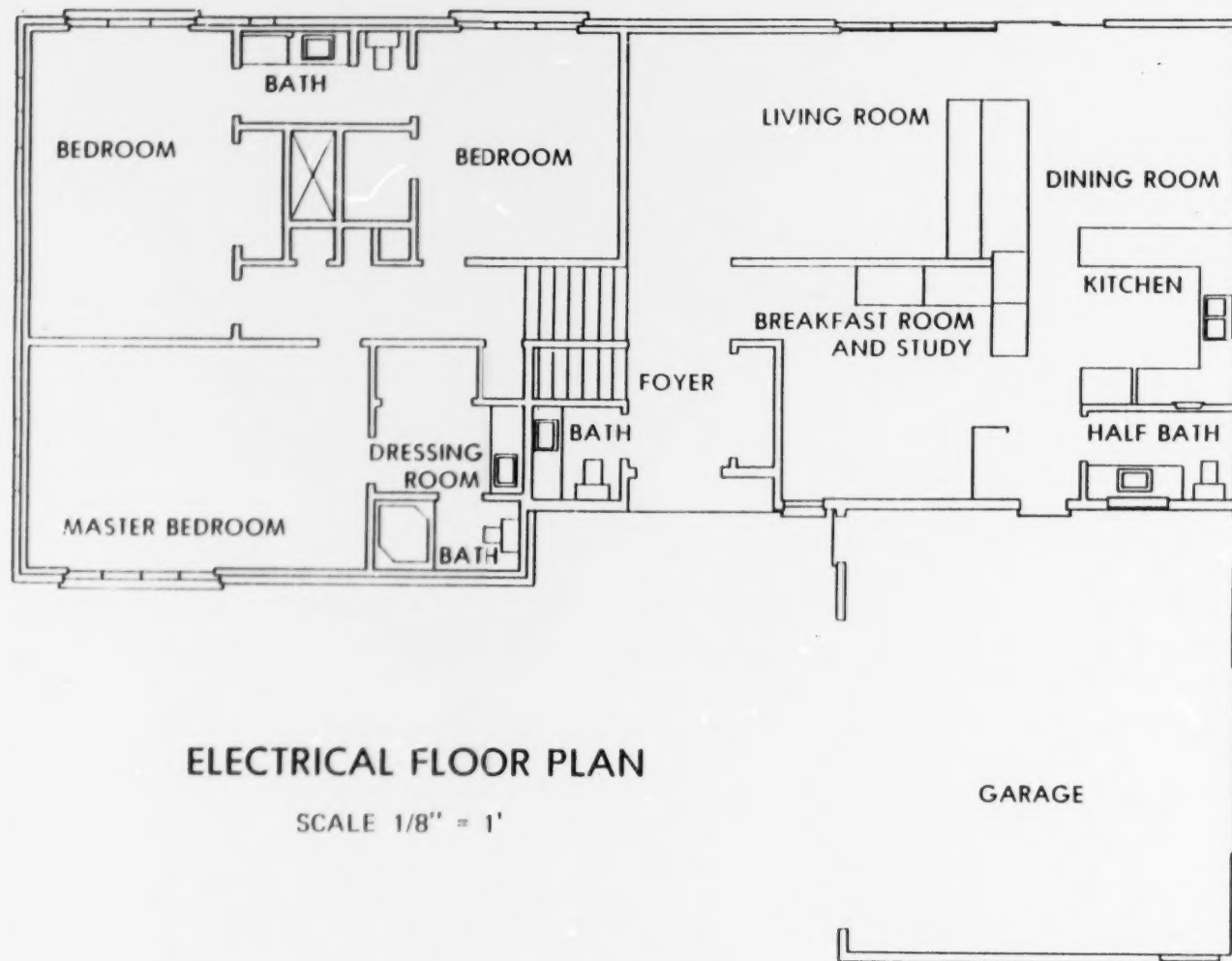
Total 16. _____ + 230 = 17. _____ amperes

(Same as 15)

LOCATE RECEPTACLE, SWITCH, AND LIGHTING OUTLETS

Problem A: Using appropriate electrical symbols, locate the minimum required receptacle outlets along the cabinet spaces on the print below.





ELECTRICAL FLOOR PLAN

SCALE 1/8" = 1'

Problem B: Using appropriate electrical symbols, locate the minimum required premise wiring system, receptacles, switches, lighting outlets, telephone outlets, and bell-buzzer outlets along the floor and ceiling on the following floor plan.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT IV: ELECTRICAL DRAWINGS

ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instruction.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT IV: ELECTRICAL DRAWINGS

UNIT TEST

Match the terms on the right with the correct definitions.

- | | | | |
|---------|--|-----|------------------------|
| ___ 1. | A basic minimum standard covering the installation of electrical equipment to safe-guard persons and property | a. | Ohm |
| ___ 2. | Unit of measure of electrical power | b. | Insulator |
| ___ 3. | One thousand watts | c. | Conductor |
| ___ 4. | Unit of measure of electrical pressure | d. | Ampere |
| ___ 5. | Unit of measure of the intensity of the flow or current of electricity | e. | Insulated conductor |
| ___ 6. | Unit of measure of the resistance to the flow of electricity | ab. | Ampacity |
| ___ 7. | A law which can be used for calculating wattage, voltage, and amperage for circuits | ac. | Grounded conductor |
| ___ 8. | Current-carrying capacity of electric conductors expressed in amperes | ad. | Ohm's Law |
| ___ 9. | Material which does not permit the free flow of electrons | ae. | National Electric Code |
| ___ 10. | Material which permits the free flow of electrons | bc. | Grounding conductor |
| ___ 11. | A conductor having no covering or electrical insulation | bd. | Covered conductor |
| ___ 12. | A conductor encased with a material not recognized by the NEC as insulation | be. | Watt |
| ___ 13. | A conductor encased with a material recognized by the NEC as insulation | cd. | Kilowatt |
| ___ 14. | A circuit conductor that is intentionally connected to the earth or some conductor that serves in place of the earth | ce. | Volt |
| ___ 15. | Connects equipment or wiring circuit grounded conductor to a grounding electrode | de. | Bare conductor |

- | | | | |
|-----------|---|-----|----------------------------------|
| _____ 16. | A complete path for current to flow from the source through the load and back to the source | a. | Distribution panel |
| _____ 17. | The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s) | b. | Raceway |
| _____ 18. | A switching device that automatically opens a circuit when the circuit has been overloaded | c. | Circuit breaker |
| _____ 19. | A wire connecting the circuit or equipment to the earth or water pipes to minimize injuries from shock | d. | Outlet |
| _____ 20. | A device that is sensitive to very low levels of current leakage to ground | e. | Receptacle outlet |
| _____ 21. | Overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it | ab. | Ground wire |
| _____ 22. | Contact device installed at the outlet for the connection of a single attachment plug | ac. | Service drop |
| _____ 23. | A point on the wiring system at which current is taken to supply utilization equipment | ad. | Low voltage |
| _____ 24. | An outlet where one or more receptacles are installed | ae. | Fuse |
| _____ 25. | The electrical enclosure that contains the overcurrent protection for circuits and connects to the service conductor | bc. | Branch circuit |
| _____ 26. | The conductors from utility pole and service head which bring the current to the building through the meter to the distribution panel | bd. | Circuit |
| _____ 27. | The overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service entrance conductors at the building or other structure | be. | Ground-fault circuit interrupter |
| _____ 28. | Wiring of less than 50 volts originating at a transformer | cd. | Receptacle |
| _____ 29. | A metal-encased box that is placed on the floor prior to placement of concrete floor to allow for various outlets | ce. | Service entrance |

- | | | | |
|---------|---|-----|-------------------------------------|
| ___ 30. | A preassembled metal box system used to distribute high-current loads | a. | Busway |
| ___ 31. | A channel or pipe, made of metal or plastic, in which conductors are run | b. | Liquid-tight flexible metal conduit |
| ___ 32. | Thin wall metal raceway of circular cross sections with integral or associated couplings, connectors, and fittings approved for the installation of electrical conductors | c. | Thousand circular mils |
| ___ 33. | Spiral metal raceway designed for flexible installation with a circular cross section and integral or associated couplings, connectors, and fittings approved for the installation of electrical conductors | d. | Knob and tube wiring |
| ___ 34. | Flexible metal conduit with an outer liquid-tight, nonmetallic, sunlight-resistant jacket | e. | Electrical metal tubing |
| ___ 35. | Similar to electrical metal tubing except that the pipe is heavier and is threaded | ab. | Rigid conduit |
| ___ 36. | Two or more wires enclosed in a flexible plastic case | ac. | Nonmetallic sheathed cable |
| ___ 37. | A flexible armor-shielded cable that has two or more conductors within the casing | ad. | Interlocked armor cable |
| ___ 38. | Wiring method using knobs, tubes, and flexible nonmetallic tubing for protection and support of single insulated conductors in walls and ceilings of buildings | ae. | Flexible metal conduit |
| ___ 39. | A standard size classification for copper and aluminum wires up to 0000 | bc. | Conduit |
| ___ 40. | The standard size classification for conductors larger than 0000 | bd. | American wire gauge |

Distinguish between types of lighting dispersement by placing an "a" next to the illustration of indirect lighting dispersement. Place a "b" next to the illustration of other types of lighting.



44. Name four parts of electrical service entrance installation.

- | | |
|----|-------|
| a. | _____ |
| b. | _____ |
| c. | _____ |
| d. | _____ |

Distinguish between types of residential branch circuits by placing an "a" next to the description of a special purpose individual circuit. Place a "b" for all other types of circuits.

- ___ 45. 15 or 20 amp circuit used for lighting and small appliances
- ___ 46. 20 amp circuit used for one or more outlets to which appliances are to be connected
- ___ 47. 115/120 volt or 208/240 volt circuit used for one single outlet

Match the wiring devices on the right with common residential applications.

- | | |
|---|---|
| ___ 48. General residential rough-in; circuit extensions in existing building; direct burial for yard lights or extensions | a. Rigid metal conduit |
| ___ 49. Extensions of existing installations; elsewhere by special permission | b. Low voltage |
| ___ 50. Through eave service masts to weatherhead; underground circuit extension; in concrete walls, floors, or ceilings; underground service riser | c. Cable |
| ___ 51. Service raceway; protecting grounding conductor | d. Concealed knob and tube wiring |
| ___ 52. Connecting recessed lighting fixtures; enclosing motor leads | e. Electrical metallic tubing |
| ___ 53. Connecting air conditioning condensers to disconnects; enclosing motor leads needing protection from liquids and vapors | ab. Raceways |
| ___ 54. Interior circuit extensions where concealed work is not necessary or is not possible; on interior concrete surfaces | ac. Flexible metal conduit |
| ___ 55. Chime circuits; intercom wiring; thermostat circuits; lighting remote control; smoke detectors; burglar alarms | ad. Liquid-tight flexible metal conduit |
| ___ 56. In locations subject to severe corrosive conditions; in portions of dairies, laundries, canneries, or other wet locations | ae. Rigid nonmetallic conduit or PVC |

Match the types of cables on the right with common applications.

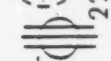
- | | | | |
|---------|--|----|------------------------------------|
| ___ 57. | Residential rough-in wiring in new construction; extensions of existing residential wiring and new remodel; feeders for sub-panels | a. | Underground cable |
| ___ 58. | Service entrance conductors if used with rain tight head; branch circuits for ranges, cook tops, or clothes dryers | b. | Service entrance cable |
| ___ 59. | Thermostat control circuits; bell or chime control circuits; low voltage lighting control circuits | c. | Nonmetallic sheathed cable |
| ___ 60. | Underground circuits to remote lighting such as yard lights; branch circuits to out buildings such as garages | d. | Underground service entrance cable |
| ___ 61. | Underground service supply | e. | Low voltage cable |
62. State the conductor letter designations for the following installation conditions.
- ___ a. Dry locations
- ___ b. Dry and wet locations
- ___ c. Dry and wet locations where more heat resistant qualities are needed.
- ___ d. Dry and wet locations where oil may be present or where more heat resistant qualities are needed.

Select true statements concerning designing an electrical system for a residence by placing an "a" in the appropriate blanks. Place a "b" in the blanks of false statements.

- ___ 63. A three-way switch is used to control a light from three locations.
- ___ 64. Switch locations should be placed so that a person can enter the house from any door and progress to any other part without being in the dark.
- ___ 65. Receptacle shall be placed so that no point on any usable wall space along the floor line is more 12" from an outlet.
- ___ 66. Split-receptacle outlets should be used in living and dining areas in order not to limit the use of radios, clocks, or appliances.
- ___ 67. Provide one receptacle near mirror in bath a minimum of 2' from water
- ___ 68. Provide one receptacle for each 10 linear feet of work surface frontage in kitchen.
- ___ 69. Provide lighting with wall switch for attic space.

Match electrical floor plan symbols on the right with the correct names.

- ___ 70. Single pole switch
- ___ 71. Three-way switch
- ___ 72. Weatherproof switch
- ___ 73. Low voltage wire
- ___ 74. Duplex receptacle outlet
- ___ 75. Split-wired receptacle outlet
- ___ 76. Range outlet
- ___ 77. 220 volt outlet
- ___ 78. Junction box
- ___ 79. Lighting outlet
- ___ 80. Round recessed light
- ___ 81. Fluorescent light
- ___ 82. Telephone
- ___ 83. T.V. antenna outlet

- a. 
- b. 
- c. Swp
- d. 
- e. S₃
- ab. 
- ac. 
- ad. S
- ae. 
- bc. 
- bd. 
- be. 
- cd. 
- ce. _____

84. Name two overcurrent circuit safety devices.

- a. _____
- b. _____

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT IV: ELECTRICAL DRAWINGS

ANSWERS TO UNIT TEST (K-2)

1. ae
2. be
3. cd
4. ce
5. d
6. a
7. ad
8. ab
9. b
10. c
11. de
12. bd
13. e
14. ac
15. bc
16. bd
17. bc
18. c
19. ab
20. be
21. ae
22. cd
23. d
24. e
25. a
26. ce
27. ac
28. ad
29. b
30. a
31. bc
32. e
33. ae
34. b
35. ab
36. ac
37. ad
38. d
39. bd
40. c
41. b
42. a
43. b

44. Any four of the following:
 - a. Electrical service line
 - b. Meter socket trough
 - c. Main disconnect switch
 - d. Distribution panel
 - e. Weatherhead assembly
45. b
46. b
47. a
48. c
49. d
50. a
51. e
52. ac
53. ad
54. ab
55. b
56. ae
57. c
58. b
59. e
60. a
61. d
62.
 - a. T
 - b. TW
 - c. THW
 - d. MTW
63. b
64. a
65. b
66. a
67. a
68. b
69. a
70. ad
71. e
72. c
73. ce
74. bc
75. ac
76. b
77. be
78. cd
79. ab
80. bd
81. d

- 82. a
- 83. ae
- 84. Any two of the following:
 - a. Fuse
 - b. Circuit breaker
 - c. Ground-fault circuit interrupter

MODULE: INTRODUCTION TO DRAFTING FIELDS

• UNIT V: INTRODUCTION TO PIPE DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify symbols used in pipe drafting, state abbreviations for words commonly used in pipe drafting, and draw single line and double line mechanical drawings, draw flow diagrams, dimension a pipe assembly, and draw isometric drawings. In addition, the student should be able to list qualifications of a piping drafter and be able to use reference materials. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

Lesson 1: Flow Diagrams

- 5.1 Match terms related to flow diagrams with the correct definitions.
- 5.2 Match types of flow diagrams with the correct definitions.
- 5.3 Identify common flow diagram valve symbols.
- 5.4 Match common flow diagram valves with the correct functions.
- 5.5 Identify common piping symbols.
- 5.6 Identify common flow diagram equipment symbols.
- 5.7 Identify common flow diagram instrumentation and electrical symbols.
- 5.8 Define instrumentation abbreviations.
- 5.9 Complete a chart of abbreviations used on flow diagrams.
- 5.10 Circle words which best complete statements concerning how to draw flow diagrams.
- 5.11 Demonstrate the ability to:
 - a. Draw piping symbols. (AS 5.1)
 - b. Draw instrumentation and electrical symbols. (AS 5.2)
 - c. Draw mechanical flow diagram equipment symbols. (AS 5.3)
 - d. Draw a mechanical flow diagram from a sketch. (AS 5.4)

Lesson 2: Pipe and Pipe Components

- 5.12 Match terms related to pipe and pipe components with the correct definitions.
- 5.13 List types of metallic and nonmetallic pipe materials.
- 5.14 Circle words which best complete statements concerning pipe size and dimensions.
- 5.15 Match types of pipe fittings with the correct characteristics.
- 5.16 Identify types of flanges.
- 5.17 Complete a chart of welded fitting and flange symbols.
- 5.18 Complete a chart of threaded fitting symbols.
- 5.19 Complete a chart of abbreviations.
- 5.20 Circle words which best complete statements concerning drawing pipe and pipe components.
- 5.21 Demonstrate the ability to:
 - a. Look up fittings from written descriptions and draw symbols. (AS 5.5)
 - b. Construct double line drawing of welded pipe fittings. (AS 5.6)
 - c. Construct single line drawings of welded pipe fittings. (AS 5.7)

Lesson 3: Pipe Drafting Standards

- 5.22 Match terms related to an orientation to pipe drafting with the correct definitions.
- 5.23 Identify types of lines.
- 5.24 Match types of working drawings with the correct definitions.
- 5.25 Identify types of templates.
- 5.26 Match piping standards with the correct purposes.

Lesson 4: Isometric Pipe Drawings

- 5.27 Match terms related to isometrics with the correct definitions.
- 5.28 List purposes of isometrics.
- 5.29 Identify information on the drawing side of an isometric.
- 5.30 Complete a chart of single line isometric symbols.
- 5.31 Select true statements concerning isometric fitting representation.
- 5.32 Circle words which best complete statements concerning drawing equipment on isometrics

- 5.33 Distinguish between correct and incorrect procedures for drawing isometrics.
- 5.34 Letter correctly in various planes.
- 5.35 Draw and correctly place a north arrow using the preferred method.
- 5.36 Draw and letter in instrumentation balloon.
- 5.37 Select true statements concerning special ballooning.
- 5.38 Circle words which best complete statements concerning connecting lines and numbers.
- 5.39 Distinguish between characteristics of vents and drains.
- 5.40 Select true statements concerning shop and field erection marks.
- 5.41 Demonstrate the ability to make a single line isometric drawing. (AS 5.8)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

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- C. Crest Engineering Company Standards. Tulsa, OK.

- D. Davis, Ronald and Donald White. Pipe Drafting. Stillwater, OK: Mid-America Vocational Curriculum Consortium, Inc., 1983.
- E. Dresser Engineering Company Standards. Tulsa, OK.
- F. Hartman, William and Fred Williams. Pipe Drafting. New York, NY: Gregg Division/McGraw-Hill Book Co., 1981.
- G. I T W Trigonometry Tables and Involute Functions. Chicago, IL: Illinois Tool Works, Inc.
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- I. Lamit, Louis Gary. Piping Systems: Drafting and Design. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1981.
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- K. Pipe Basics Manual. Pittsburgh, PA: United States Steel, 1975.
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- M. Weaver, Rip. Process Piping Design. Volume 1. Houston, TX: Gulf Publishing Co., 1973.

NOTES TO THE INSTRUCTOR

- A. Suggested approaches to teaching this unit
 - 1. **Lesson 1: Flow Diagrams**
 - a. Have students locate different symbols in the ISA Code Book.
 - b. Discuss with students how to locate line numbers on a pipeline index.
 - c. Have students look at a material specification list and locate types of material.
 - d. Contact an engineering company to obtain a set of flow sheets, piping plans, piping elevation, line index, isometric drawings, and company standards to use as examples for the students.
 - e. Use the master copies of Transparencies 1-5 to make a process flow diagram. Tape together and fold so you can show students what a process flow sheet looks like.
 - f. Explain to students that the dimensions shown on flow symbols in this unit indicate the way the symbols need to be drawn, but stress that drafters do not actually measure symbols on the job. They should strive to keep symbols proportional.
 - 2. **Lesson 2: Pipe and Pipe Components**
 - a. Explain to students about pipe manufacturing methods using detailed information in USS Pipe Basics Manual.
 - b. Make slides of pipe components for viewing by students.

- c. Discuss fittings and their available pressure ratings.
- d. Take a field trip to a small petroleum-related plant to see piping connection arrangements. If plant is not available, visit a local gas distribution meter station.
- e. Provide small PVC pipe and fittings for students to assemble as a way to aid in the visualization of piping arrangements.
- f. Provide manufacturers' catalogs for the students to use in the assignment sheets.
- g. Provide piping templates for students to use in the assignment sheets.

3. Lesson 3: Pipe Drafting Standards

- a. Provide a set of working drawings and explain to students that one drafter does not make all the drawings but works on a team for completion of drawings.
- b. Obtain copies of reference materials from manufacturers' supply companies or welding companies or write to the following suggested list:

- 1) Pipe Fitters Manual
Tube Turns Division
Chemetron Corporation
P.O. Box 32160
Louisville, Kentucky 40232
- 2) Pipe Basics Manual
United States Steel
600 Grant St.
Pittsburgh, Pennsylvania 15230

NOTE: You may wish to contact the nearest USS district sales office for available publications.

- 3) The Pipe Fitters Blue Book
W.V. Graves
233 South Virginia St.
La Porte, Texas 77571
- 4) The Dearman System
Dearman International Inc.
P.O. Box 937
Pearland, Texas 77581

4. Lesson 4: Isometric Pipe Drawings

- a. Order trigonometry function books such as the one listed in the above references for the students to use in AS 1.1, and discuss how to use these books.
- b. Use PVC pipe and fittings or pipe cleaners to help students visualize isometric views.
- c. Supply students with isometric sketch pads and blank 11 x 17 isometric drawing sheets.
- d. Show the students as many different types of fittings as possible.

- e. Visit a pipe fabrication shop.
- f. Locate and obtain a model of a plant.
- g. Provide vendor catalogs for use as reference materials.
- h. You may wish to give the unit test in two parts. Since students will be drawing some on the test, have templates available.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 1: FLOW DIAGRAMS

I. Terms and definitions

- A. **Blind flange**--solid plate-like fitting used to seal the end of a flanged-end pipeline

NOTE: This can be used with any other flange to stop the flow 100%

- B. **Car seal**--a device used to show that something has not been tampered with

NOTE: Every electrical meter box on a house is car seal closed.

- C. **Downstream**--in the direction of the product flow

- D. **Equipment**--large implements used in the operation of a plant

- E. **Flange**--a method of joining pipe components and equipment for later dismantling and maintenance of equipment

- F. **Flow diagram**--a schematic diagram not drawn to scale that shows direction of flow on lines and equipment, and indicates size, temperature, pressure, and flow rate

NOTE: These are commonly called flow sheets.

- G. **Instrument air**--oil-free, moisture-free, compressed air system used to operate pneumatic control devices

- H. **Instrument**--a device used to control and/or indicate temperature, pressure, level, or flow in a pipe or equipment

- I. **Insulation**--material used on the outside of pipe or equipment to keep temperature constant and to protect personnel

- J. **Locally mounted**--located near the piping or equipment

NOTE: This is sometimes on the piping or equipment and sometimes on the ground.

- K. **Material balance**--calculations completed by an engineer to show the end product, chemical position, impurity level, and all important aspects of a material being processed

NOTE: This is commonly shown in the form of a chart on the process flow diagram. If there is not room on the process diagram, it may be shown on a separate sheet.

- L. **Panel board mounted**--located in a control room on a control board

Example: Car dashboard

- M. **Pipe**--a tubular or cylindrical shape used for transporting gases, liquid, or fine solids or for structural support

- N. **Pneumatic**--moved or worked by air pressure
- O. **Reducer**--a pipe fitting used to reduce or enlarge a pipe to a different size
- P. **Schematic diagram**--any line drawing which illustrates the arrangement and relationship of the parts

NOTE: It is meant to explain rather than represent.
- Q. **Skid**--a large flat structure that has several pieces of equipment mounted on it for easier moving if needed

NOTE: This is like a sled, only larger.
- R. **Upstream**--in the direction opposite to the product flow
- S. **Utility air**--air line used in cleanup operations, to drive motors, and other service functions

NOTE: Utility air and instrument air must be kept separate.
- T. **Vessel**--container used in a piping system to hold, transform, or store a medium
- U. **Valve**--a device installed in a flow line to stop or control temperature, pressure, or flow rate
- V. **Weld cap**--bowl-shaped component welded to an open end of pipe to stop flow

II. Types of flow diagrams and definitions (TMs 5.1-5.7)

NOTE: When TMs 5.1 through 5.5 are put together, they make one process flow diagram.

- A. **Process**--used by process engineers in designing what major equipment and lines are needed in a plant
- B. **Mechanical**--derived from process flow diagram and used in sizing pipe, system specifications, insulation, line numbers, and instrumentation controls

NOTE: This may also be called a P&ID, piping and instrumentation gram.
- C. **Utility**--derived from mechanical flow diagrams and shows all other piping, system specifications, and minor equipment needed to make the plant run

NOTE: In general, anything that is not directly associated with the primary process in a plant can be considered a utility. Mechanical flow diagrams and utility flow diagrams are both used by mechanical engineers in sizing pipe, system specification, and valve location and by drafters in the drawing of piping plant.

III. Common flow diagram valve symbols

NOTE: The following symbols are depicted here as normally open (N.O.) If they should be normally closed (N.C.), they should be drawn darkened in.

A. Gate valve



B. Globe valve



C. Plug valve



D. Ball valve



E. Check valve



NOTE: Arrow indicates flow direction.

F. Control valve



G. Control valve (Butterfly pattern)



H. Pressure safety valve or relief valve



IV. Common flow diagram valves and functions

- A. Gate valve--used fully opened or completely closed for start/stop operations
- B. Globe valve--used to manually control pressure or flow rate in a line
- C. Plug valve--used in minimum space installations, has a 90° or 1/4 turn opened or closed position, and has limited throttling ability
- D. Ball valve--used mainly for opened or closed positions, but may be used for regulating flow; usually has a tight shut off position
- E. Check valve--used to stop the flow of liquid or gas in a line automatically in one direction only
- F. Control valve (and butterfly valve)--used to regulate pressure, flow direction, or operation sequence
- G. Pressure safety valve or relief valve--used on a line to relieve pressure greater than the normal design pressure in that line

V. Common piping symbols

- A. Pipe flow routing



- B. Valves on a line

1. Flanged



2. Screwed (or threaded)



- C. Concentric reducer



- D. Eccentric reducer



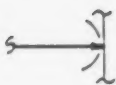
- E. Flow direction arrow



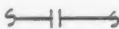
- F. Flow diagram transfer symbol (balloon)



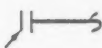
G. Line number break



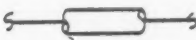
H. Flange connection



I. Blind flange



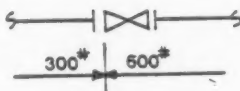
J. Insulation on pipe



K. Weld cap



L. Line rating change



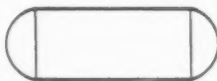
NOTE: Symbols vary from company to company.

VI. Common flow diagram equipment symbols (TMs 5.8-5.11)

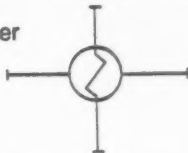
A. Vertical vessel, tower, or scrubber



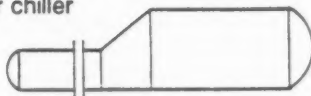
B. Horizontal vessel



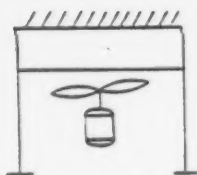
C. Heat exchanger



D. Reboiler or chiller



E. Air fin exchanger



F. Mounted type pump



G. Inline type pump



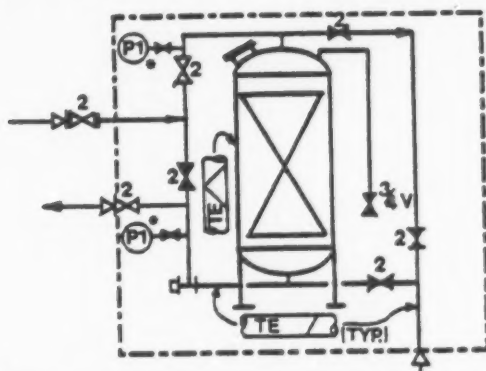
H. Storage tank



NOTE: There are many variations and types of equipment. See TMs 5.8-5.11 for other examples.

I. Skid-mounted equipment

NOTE: Dashed line indicates skid boundary. Everything inside dashed line is skid mounted.



VII. Common flow diagram instrumentation and electrical symbols

A. Locally mounted instrument



B. Control room mounted or board mounted instrument



C. Field board mounted instrument

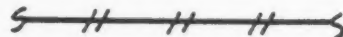


- D. Mounted behind the board instrument



NOTE: The appropriate abbreviations such as TI, TRC, and others, and the appropriate numbers will appear in the circles.

- E. Instrument air or pneumatic signal flow line



- F. Electrical signal line



VIII. Instrumentation abbreviations

- A. Initial (first) letter

1. F--Flow
2. L--Level
3. LL--Liquid level
4. P--Pressure
5. T--Temperature

NOTE: Sometimes an H is the first letter which means it is hand operated.

- B. Subsequent letters

1. E--Element
2. I--Indicating or indicator
3. C--Control or controller
4. V--Valve
5. R--Recorder

NOTE: When dealing with pressure, this may also stand for regulator or reducing.

6. G--Gage
7. A--Alarm
8. d--differential

Example: PdC--Pressure differential controller

9. W--Well

10. S--Switch

Examples:

LG--Level gage

FICV--Flow indicating control valve

LLI--Liquid level indicator

PC--Pressure controller

TR--Temperature recorder

IX. Abbreviations used on flow diagrams

@	At	NO	Normally open
°C	Degrees Centigrade	NC	Normally closed
CH-O	Chain-operated	NTS	Not to scale
CONN	Connection	OD	Outside diameter
CSC	Car seal closed	P	Pressure point
CSO	Car seal opened	PSI	Pounds per square inch
CF	Cubic feet	PSIA	Pounds per square inch absolute
CFM	Cubic feet per minute	PSIG	Pounds per square inch gravity
D	Drain	SC	Sample connection
DWG	Drawing	SCFM	Standard cubic feet per minute
°F	Degrees Fahrenheit	SCRD	Screwed
FLG	Flange	S/S	Seam to seam
FR	From	T	Threaded
*	Furnished with equipment	TYP	Typical
GPM	Gallons per minute	V	Vent
HDR	Header	VA	Valve
ID	Inside diameter		
MF	Mechanical flow		
MMSCFD	Million modules squared cubic feet a day		

X. How to draw flow diagrams (TMs 5.12-5.17)

A. Flow diagram sizes

1. Process flow diagram is drawn on 24", 30", or 36" wide roll paper; length can be 5' to 50'.
2. Mechanical flow diagram is drawn on 22" x 34" or 24" x 36" size paper.
3. Utility flow diagram is drawn on 22" x 34" or 24" x 36" size paper.

B. Flow diagrams are not drawn to scale; that is, a line or piece of equipment cannot be measured to determine its actual size.

NOTE: The dimensions on the following symbols are to show you approximate size only. Company practices vary on this. The most important thing to remember is that symbols should be uniform and proportional.

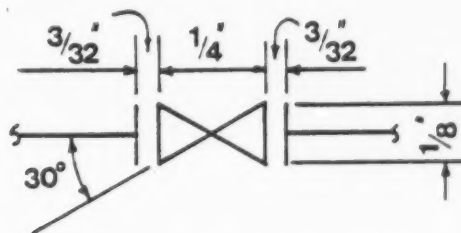
C. Piping flow symbols

1. Piping flow routing lines are drawn thin dark.

Example: 

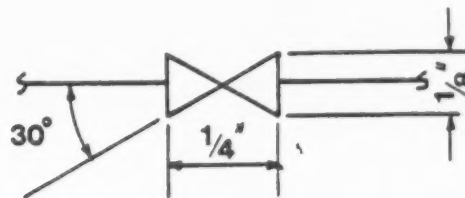
2. Flanged valves are drawn $1/4"$ long and $1/8"$ high with 30° angles; flanges are drawn same height $3/32"$ from valve.

Example:



3. Screwed valves are drawn $1/4"$ long and $1/8"$ high with 30° angles.

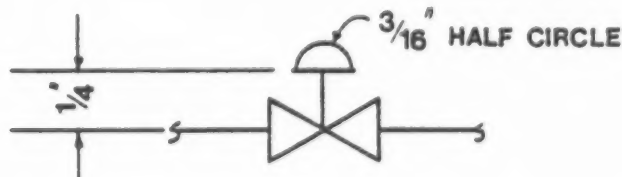
Example:



NOTE: Any pipe or component 2" or larger is flanged. Any pipe or component smaller than 2" is screwed unless specified otherwise.

4. Control valves are drawn the same as screwed or flanged valves except for showing the actuator which is drawn $1/4"$ above pipe flow line with $3/16"$ half circle.

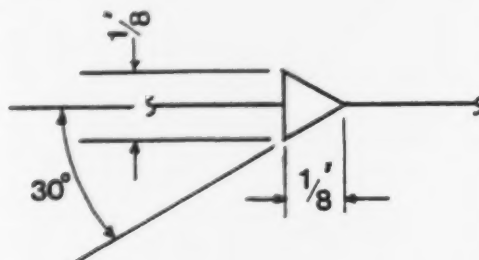
Example:



D. Reducers

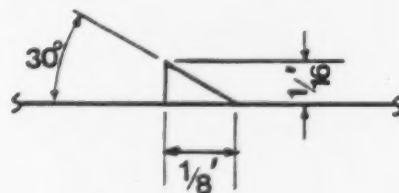
1. Concentric reducers are drawn as if they were 1/2 of a gate valve.

Example:



2. Eccentric reducers are drawn as if they were 1/2 of a concentric reducer.

Example:



- E. Flow direction arrows are drawn as standard arrowheads.

Example:



NOTE: For placement of flow arrows, see examples in the transparencies.

- F. Insulation symbols

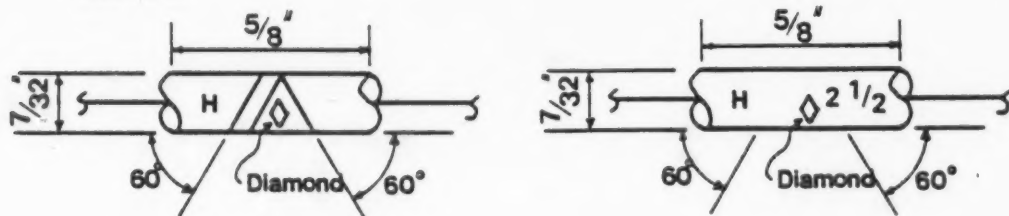
1. These are drawn 7/32" high and 5/8" long with a circle cylinder break.
2. If diagonal lines are used to indicate number of full inches (left side) and number of half inches (right side) of insulation, the diagonal lines slant 60° off the horizontal line.

NOTE: Some companies do not use diagonal lines. Instead they indicate the number of full and half inches of insulation in numeric form—2 1/2 means two and one-half inches of insulation.

3. Flange marks are drawn as a small diamond.

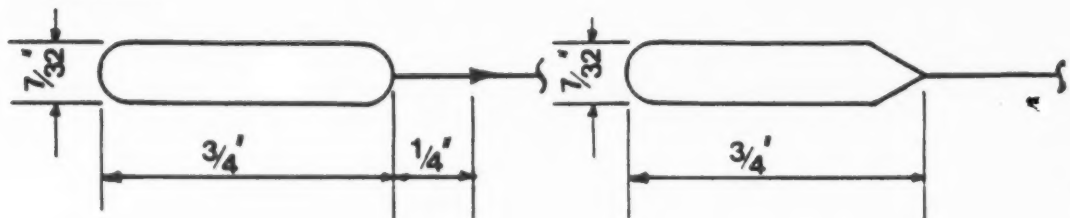
NOTE: Type of insulation is indicated with the following abbreviations: H-Hot, C-Cold, HT-Heat trace, ST-Steam trace, and HP-Hot personal.

Examples:



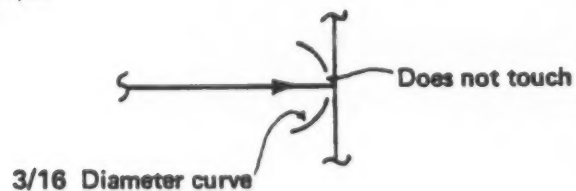
- G. Flow diagram transfer symbols are drawn $7/32$ " high and $3/4$ " long as shown in either of the following examples. (Ballooning)

Examples:



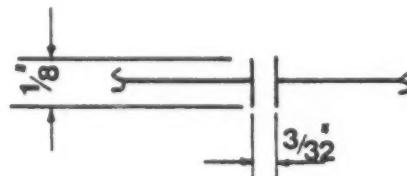
- H. Line number break symbols are drawn with a $3/16$ " diameter curve (only half of the circle is shown) and do not touch the flow line.

Example:



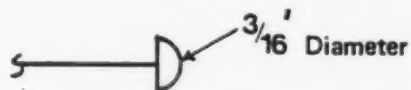
- I. Flange symbols are drawn $1/8$ " high with $3/32$ " gap between flange marks.

Example:



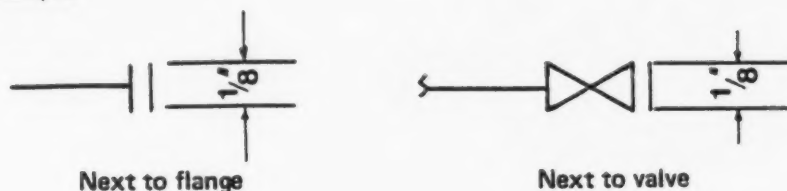
- J. Weld caps are drawn $1/2$ of a $3/16$ " diameter circle.

Example:



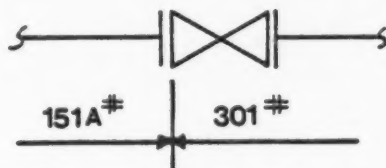
- K. Blind flanges are drawn $1/8$ " high next to a valve or flange.

Example:



- L. Line rating changes are usually placed by a valve or between flanges about $1/2$ " from the flow line.

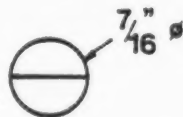
Example:



- M. Instrument symbols

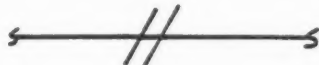
1. Instrument callouts are drawn in a $7/16$ " diameter circle.

Example:



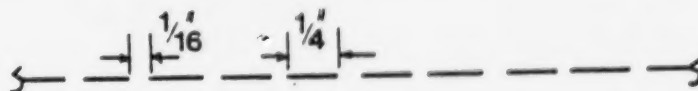
2. The diagonal slash marks in pneumatic lines are drawn $1/8$ " high at a 45° angle with no more than $1/16$ " distance between.

Example:



- N. Electrical lines are drawn as thin hidden lines with an open flow arrow to indicate direction of electrical signal.

Example:



- O. Laying out a drawing

1. Lay out drawing with light construction lines.
2. Allow 3 1/2" from top border line for equipment titles.
3. Allow 3 1/2" above title block for main process flow lines and transfer symbols.
4. Space vertical equipment between equipment titles and 3 1/2" space allowed for main flow lines.

NOTE: Small equipment symbols can be placed on top of one another.

5. Space horizontal equipment to allow for flow lines and instrument symbols.

- P. Flow lines

1. Flow lines are drawn from equipment to equipment.
2. Flow lines running horizontally have preference over vertical lines, and the vertical line is always broken.
3. All flow lines are at least 1/4" apart.

- Q. Flow symbols are placed where needed in or on the flow line.

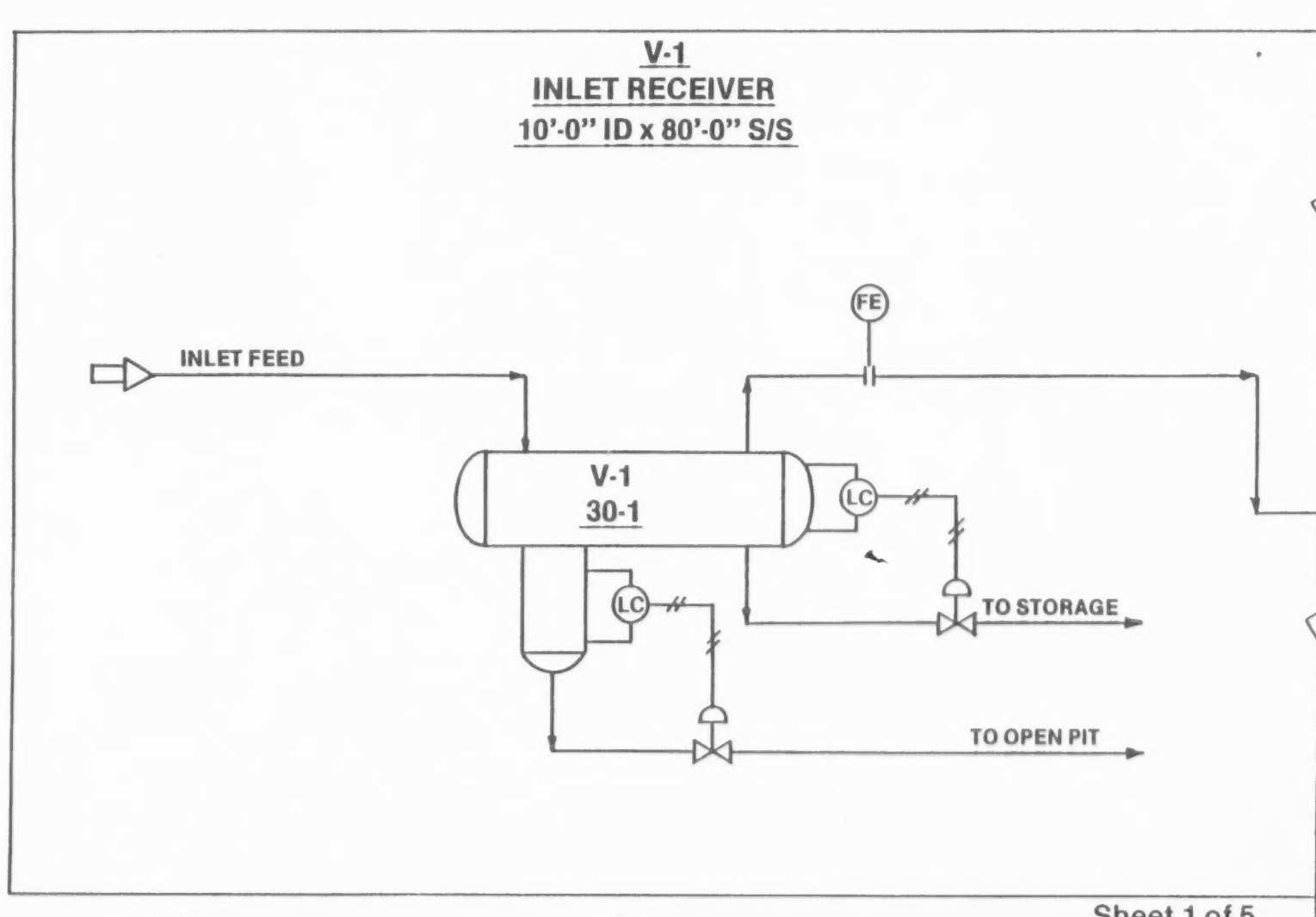
- R. Instrument symbols are placed where they are needed.

Examples: Above valve, next to equipment.

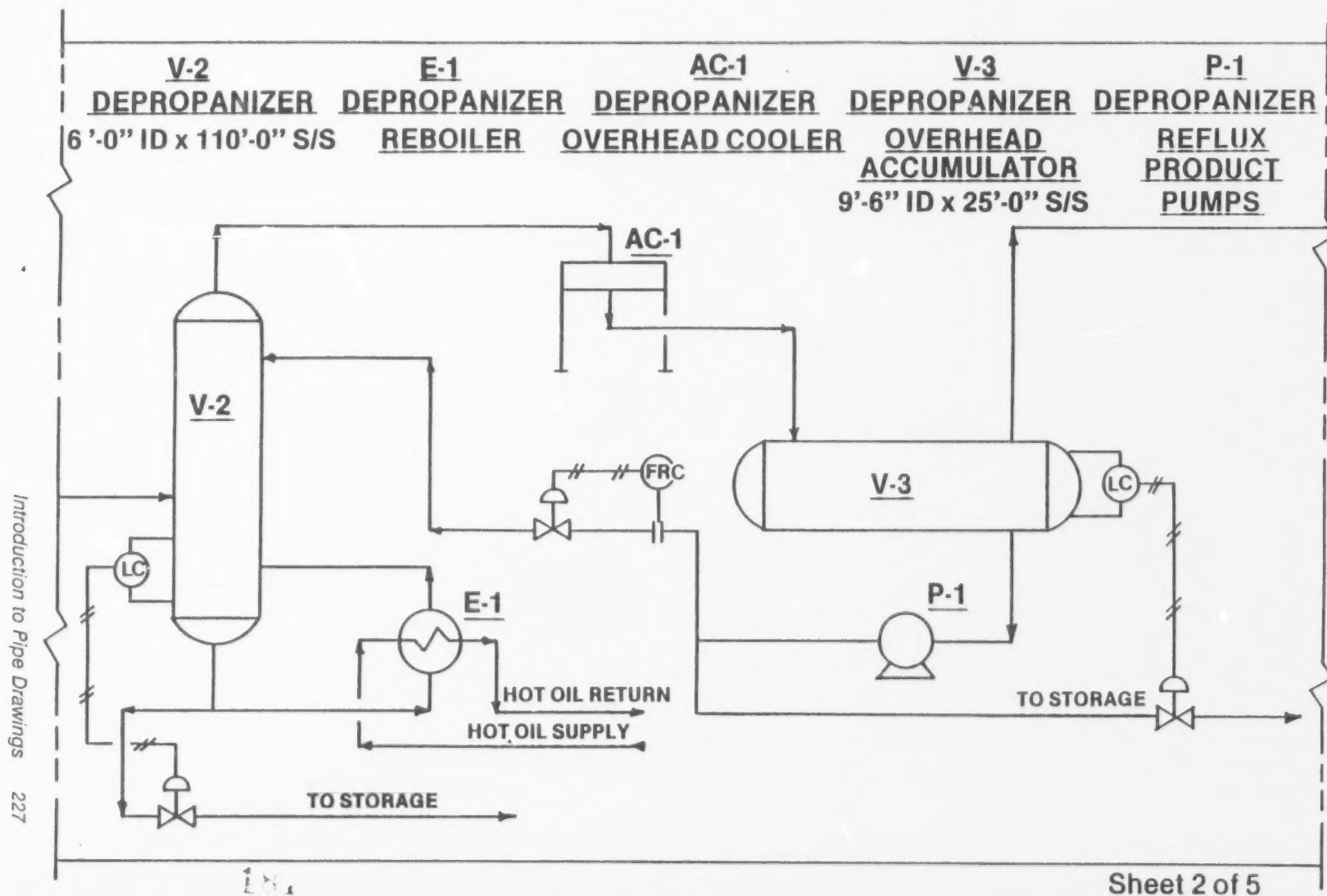
- S. Legible lettering is required.

- T. Darkening in all lines is the last step in drawing a flow diagram.

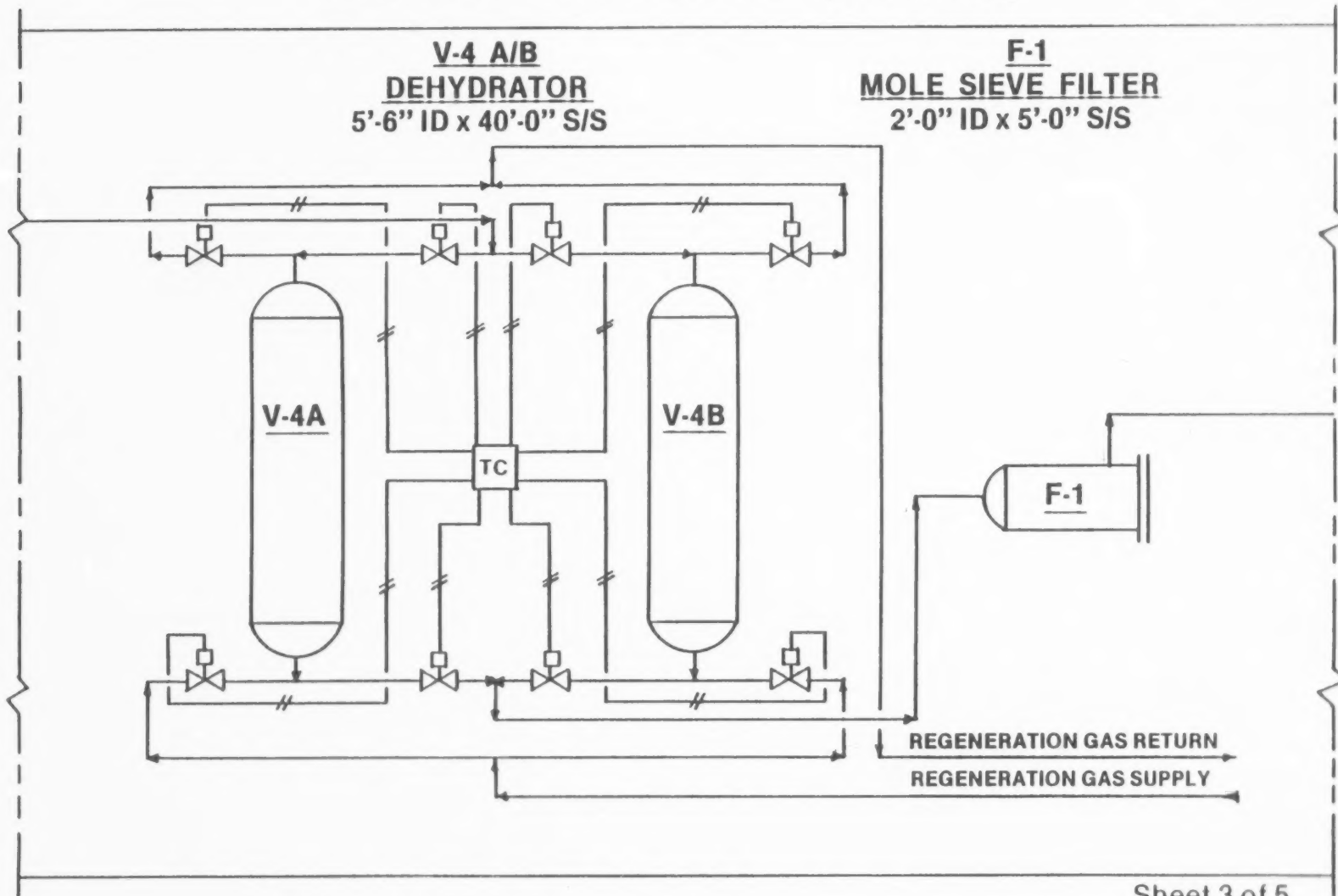
PROCESS FLOW DIAGRAM



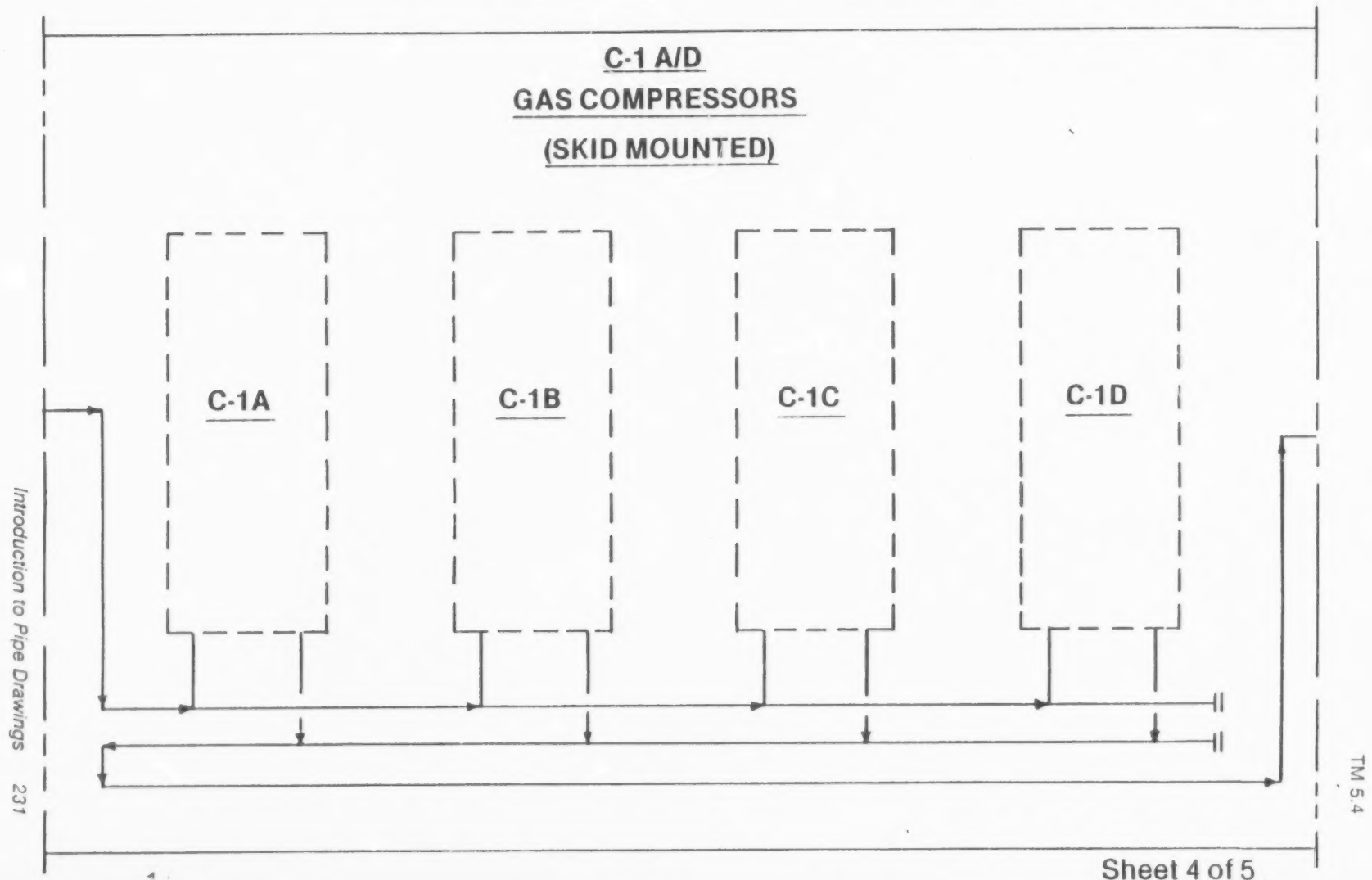
PROCESS FLOW DIAGRAM (continued)



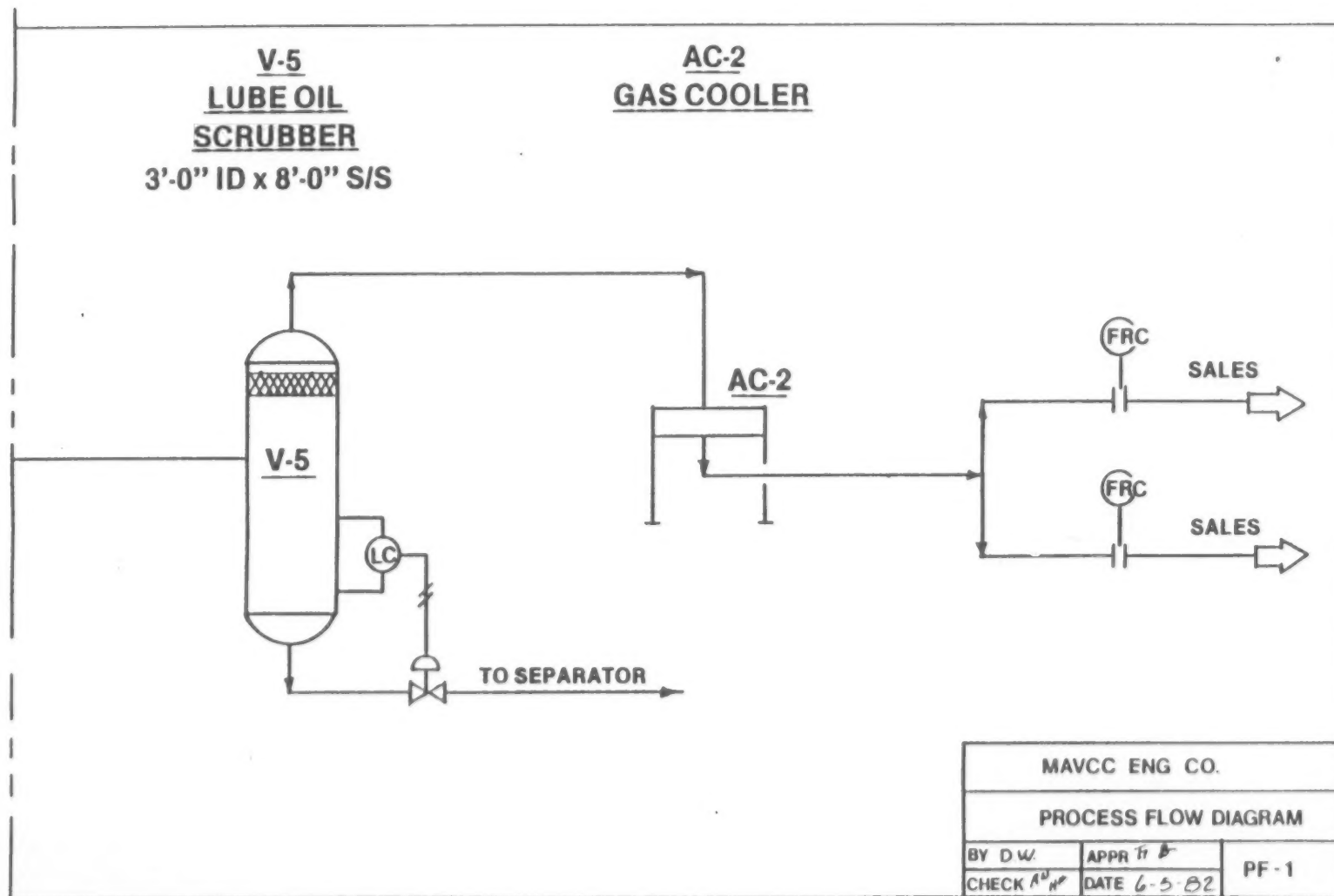
PROCESS FLOW DIAGRAM (continued)



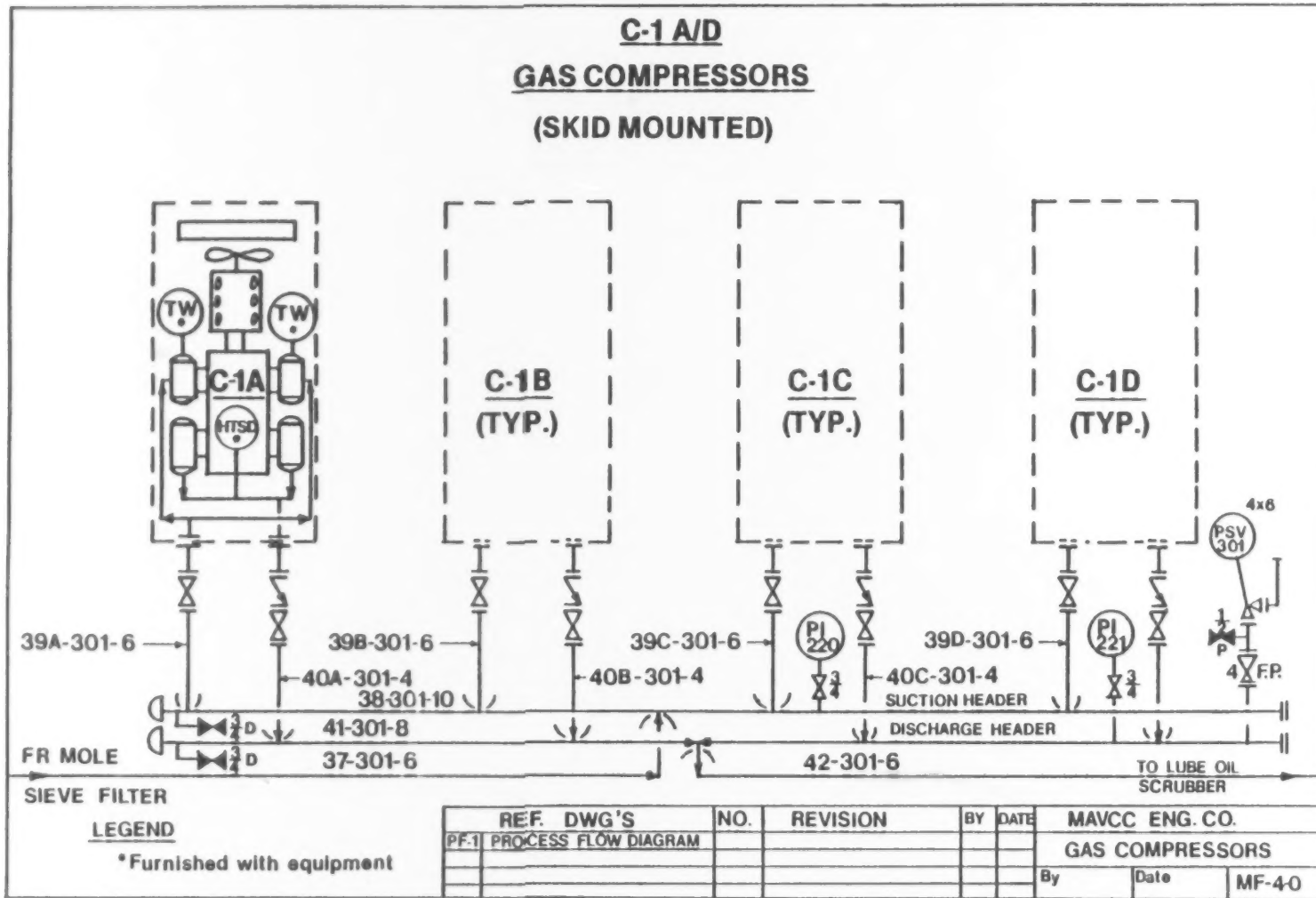
PROCESS FLOW DIAGRAM (continued)



PROCESS FLOW DIAGRAM (continued)

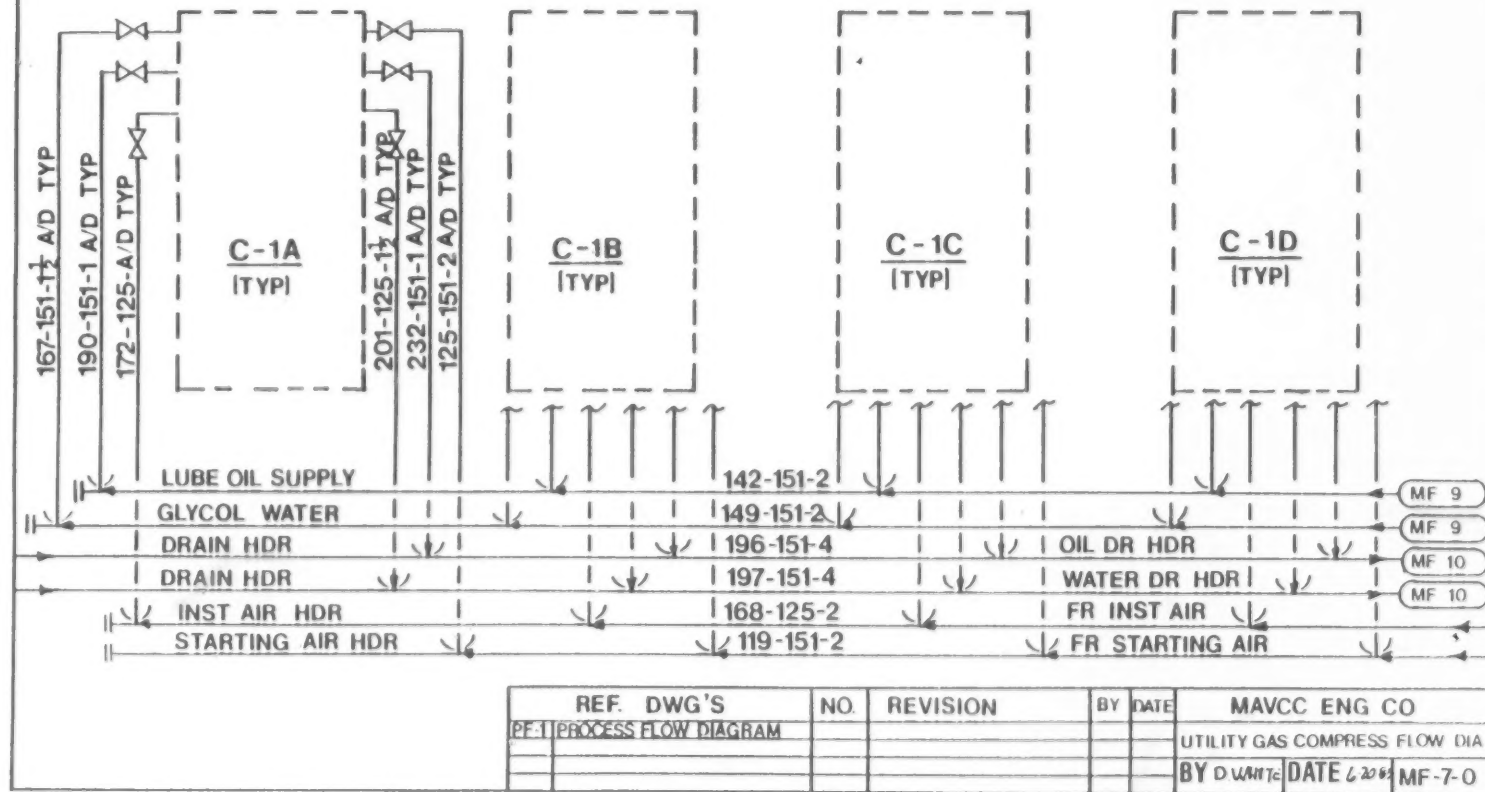


MECHANICAL FLOW DIAGRAM

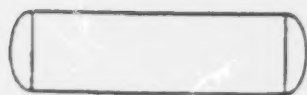


UTILITY FLOW DIAGRAM

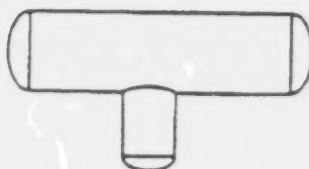
C-1 A/D GAS COMPRESSORS (SKID MOUNTED)



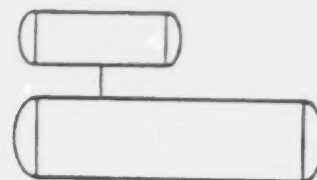
EQUIPMENT SYMBOLS



HORIZONTAL
SCRUBBER



HORIZONTAL SEPARATOR
WITH POT



HORIZONTAL SEPARATOR
WITH GAS SECTION



VERTICAL
SCRUBBER

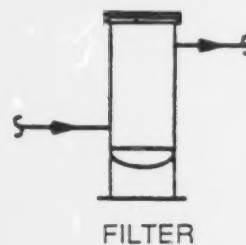
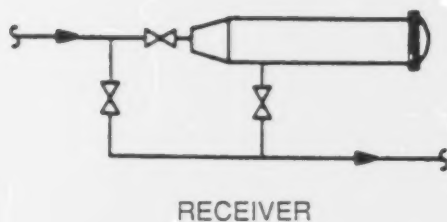
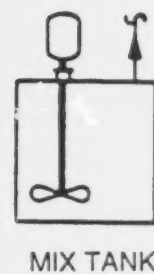
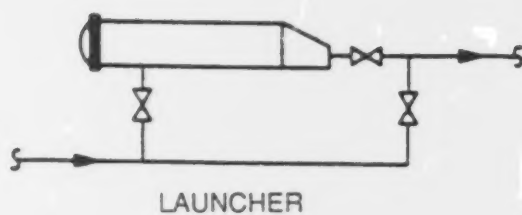
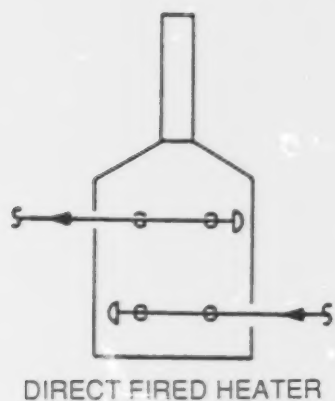


VERTICAL
SCRUBBER

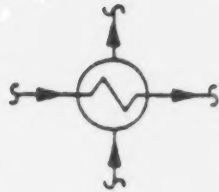


RICH OIL
FRACTIONATOR

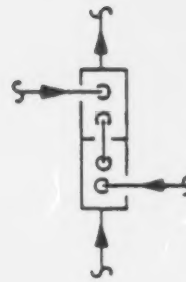
EQUIPMENT SYMBOLS (continued)



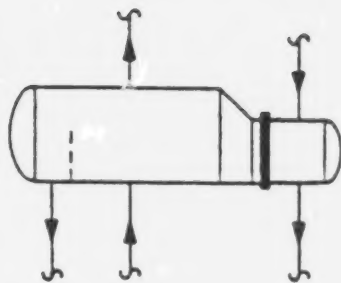
EQUIPMENT SYMBOLS (continued)



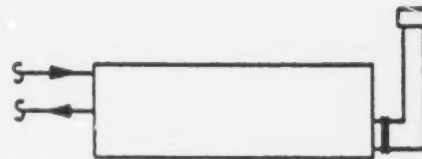
SHELL AND TUBE
HEAT EXCHANGER



FIN TUBE HEAT
EXCHANGER

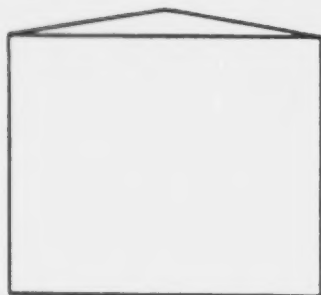


REBOILER/CHILLER

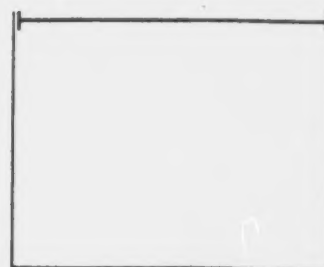


INDIRECT FIRED
HEATER

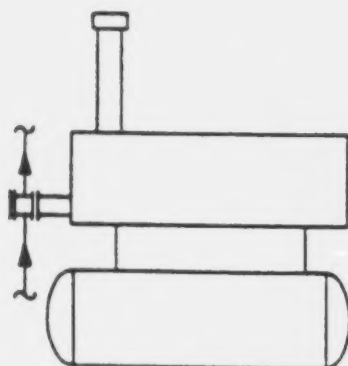
EQUIPMENT SYMBOLS (continued)



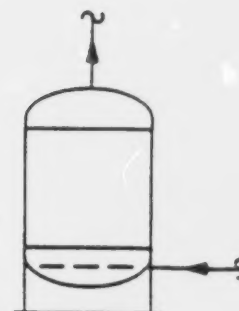
CONE ROOF TANK



FLOATING ROOF TANK



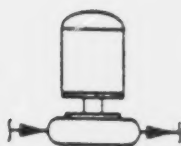
GLYCOL
RECONCENTRATOR



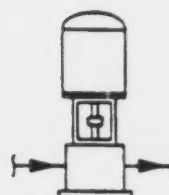
SEA WATER FILTER



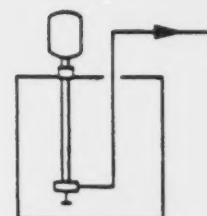
CENTRIFUGAL
PUMP



VERTICAL INLINE
PUMP

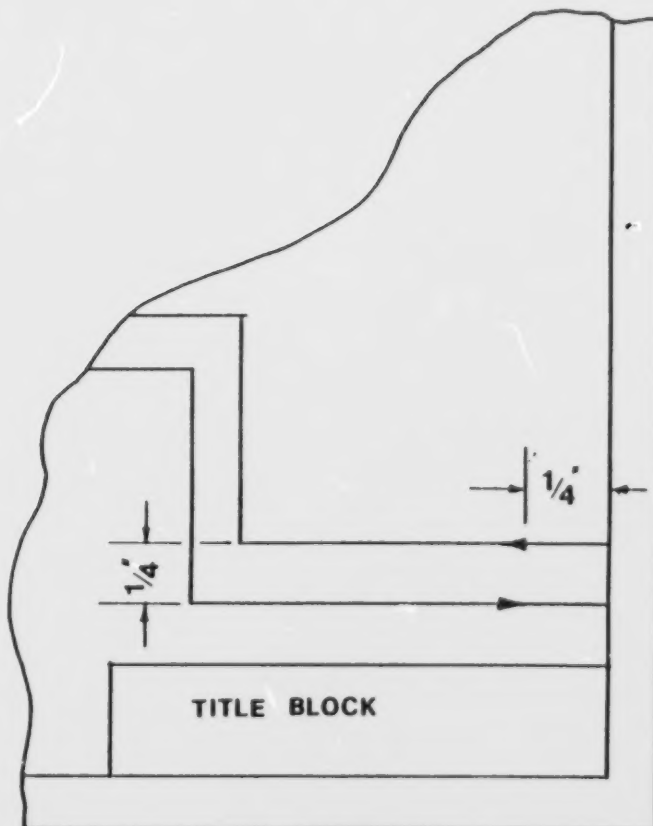


CAN TYPE
PUMP

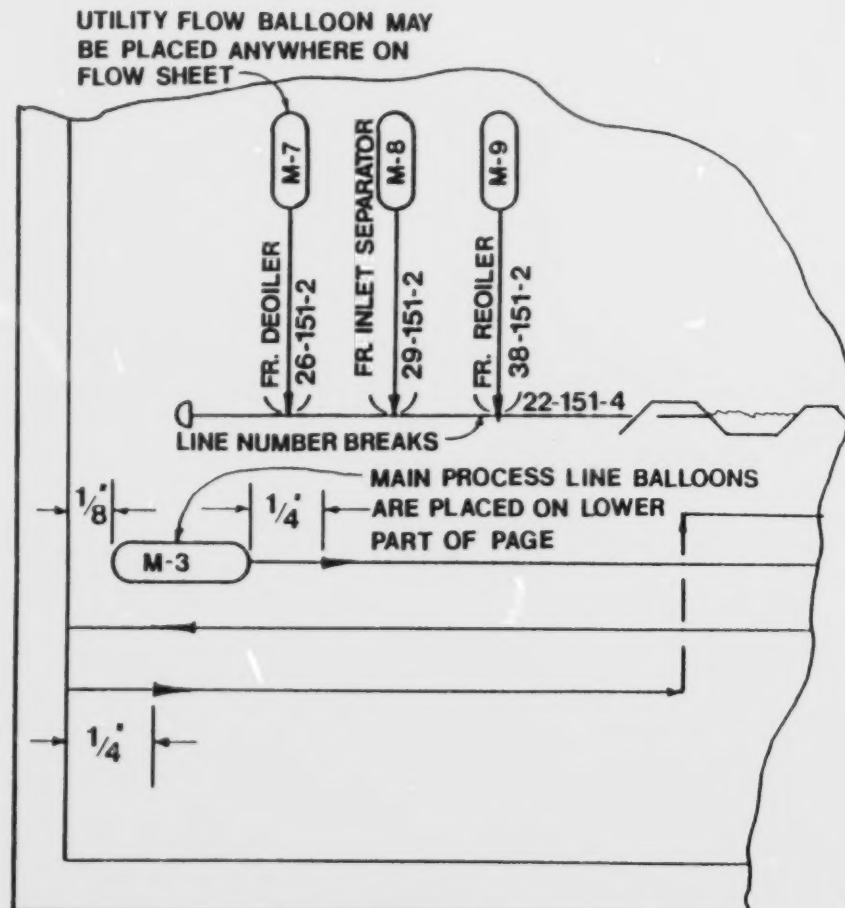


SUMP AND PUMP

FLOW ARROWS, BALLOONING, AND LINE BREAKS



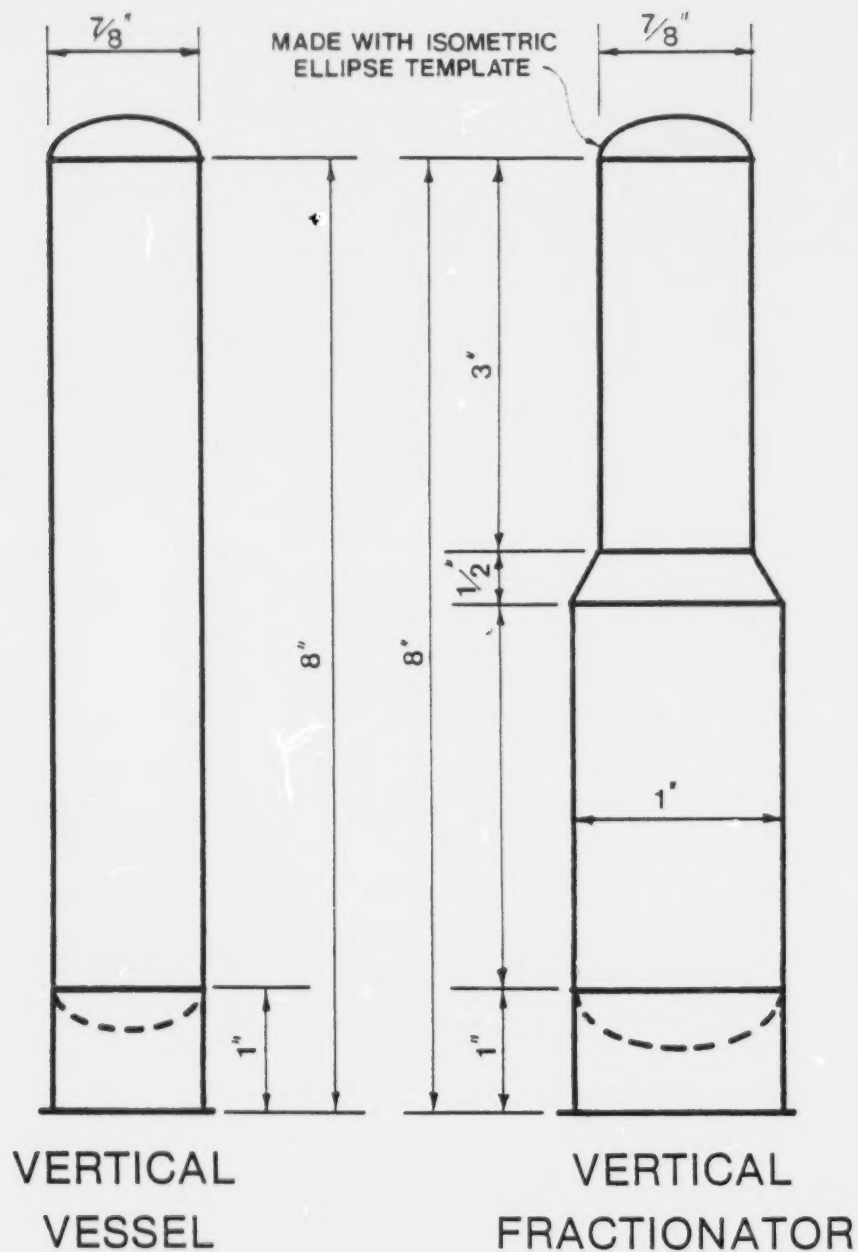
SHEET 15



SHEET 16

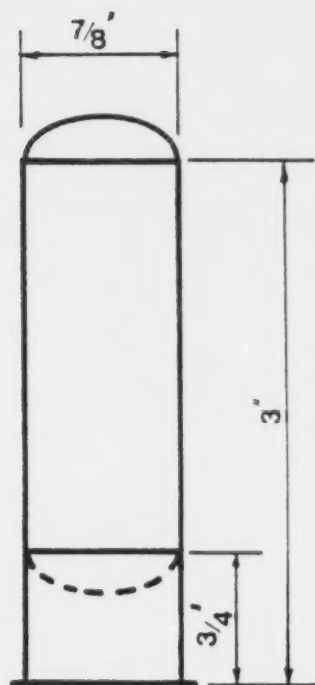
TM 5.12

MECHANICAL FLOW EQUIPMENT SYMBOLS

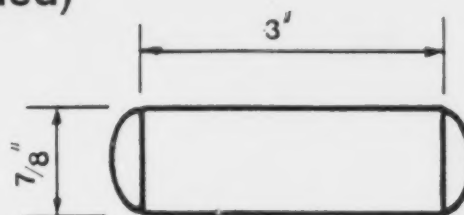


(NOTE: Dimensions on this and the following TMs are only here to indicate proportion.)

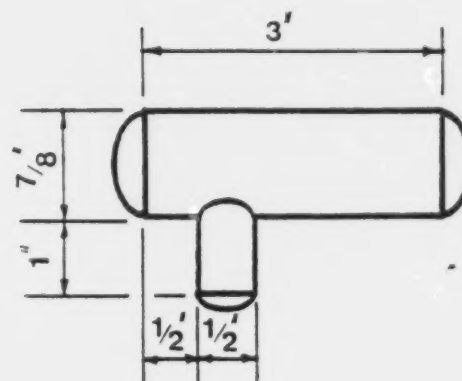
MECHANICAL FLOW EQUIPMENT SYMBOLS (continued)



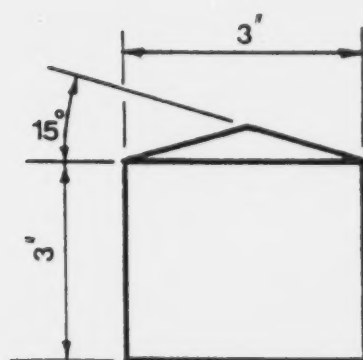
VERTICAL SCRUBBER



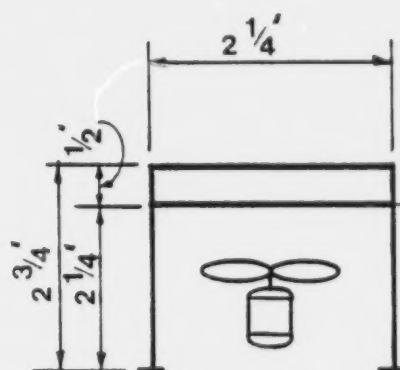
HORIZONTAL VESSEL



HORIZONTAL SEPARATOR

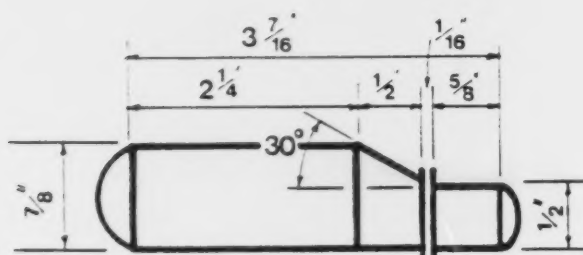


STORAGE TANK

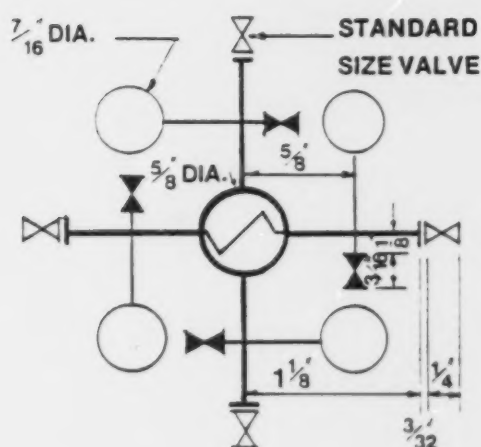


AIR COOLER
(FIN FAN)

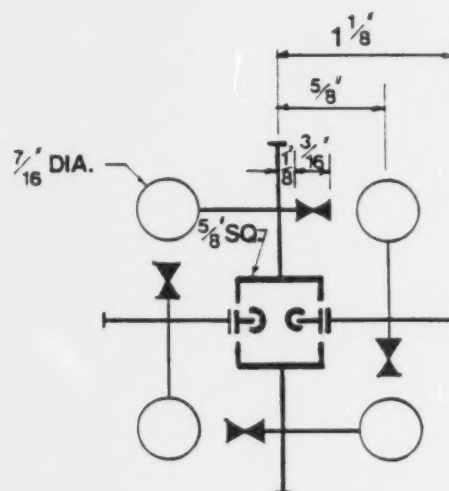
MECHANICAL FLOW EQUIPMENT SYMBOLS (continued)



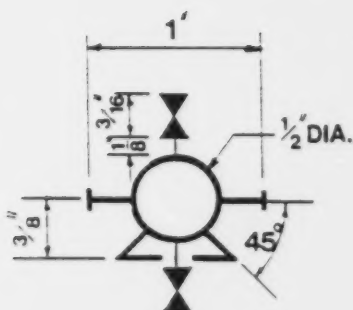
REBOILER
OR CHILLER



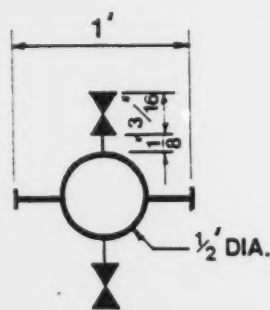
SHELL AND TUBE
EXCHANGER



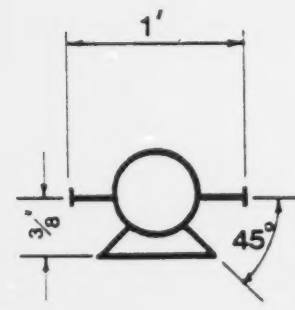
FIN TUBE
EXCHANGER



CENTRIFUGAL PUMP

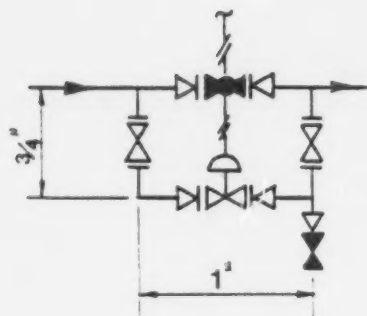


INLINE PUMP

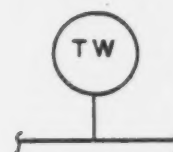


CAN TYPE PUMP

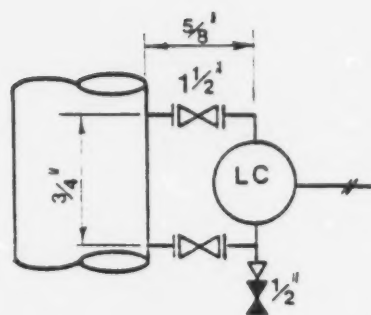
MISCELLANEOUS FLOW DIAGRAM SYMBOLS



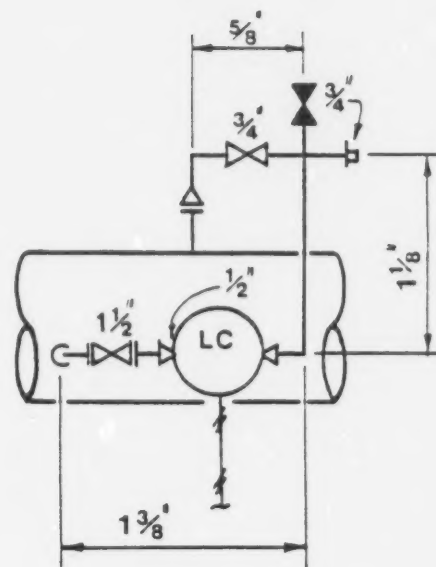
FLANGED
CONTROL VALVE
SETTING



SCREWED
TEMPERATURE WELL

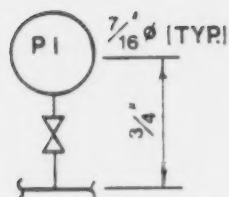


FLANGED
LEVEL CONTROLLER

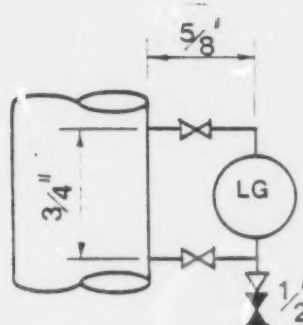


DIFFERENTIAL
PRESSURE
LEVEL CONTROLLER

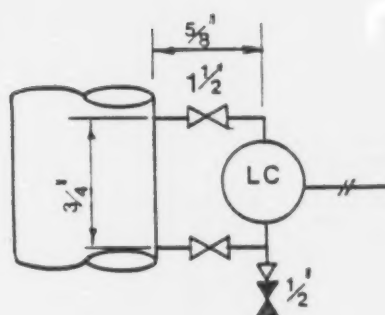
MISCELLANEOUS FLOW DIAGRAM SYMBOLS (continued)



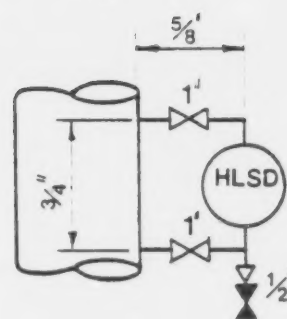
SCREWED
PRESSURE INDICATOR



SCREWED
LEVEL GAGE



SCREWED
LEVEL CONTROLLER



SCREWED
ALARMS AND
SHUTDOWNS

DRAW PIPING SYMBOLS

Directions: Draw the following piping flow symbols to an appropriate proportion "A" size paper. Label each symbol.

NOTE: You may want to refer to examples provided by instructor.

Problems:

- A. Screwed gate valve

- B. Flanged globe valve

- C. Flanged control valve

- D. Concentric reducer

- E. Flow diagram transfer symbol (balloon)

- F. Insulation symbol with 2 1/2" cold insulation and flanges insulated

- G. Weld cap

- H. Blind flange connected to a flanged gate valve

DRAW INSTRUMENTATION AND ELECTRICAL SYMBOLS

Directions: Draw the following instrumentation and electrical symbols to an appropriate proportion on "A" size paper.

Problems:

- A. Locally mounted instrument symbol for a temperature indicator number 301
- B. Control room mounted instrument symbol for a pressure indicator number 229
- C. Mounted behind the board symbol for a pressure indicating controller number 513
- D. Two locally mounted instrument symbols 4" apart and connected with an instrument air signal flow line
- E. Two instrument symbols, one board mounted and one locally mounted, 4" apart and connected with an electrical signal line

DRAW MECHANICAL FLOW DIAGRAM EQUIPMENT SYMBOLS

Directions: On "C" size paper, draw the following equipment. Space appropriately with eye and label all equipment at the top of the sheet. Remember to lay out all equipment very lightly to see that all will fit on paper before darkening any in.

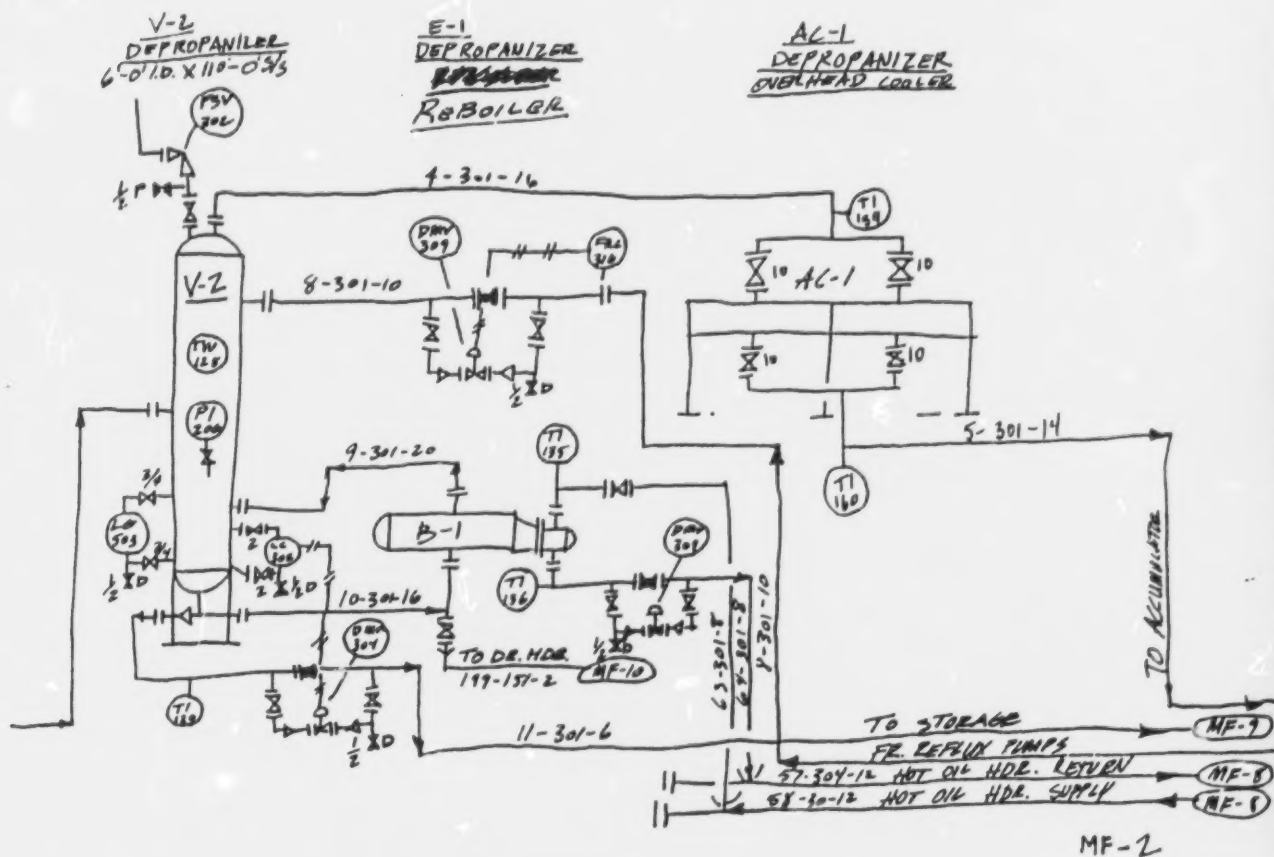
Problems:

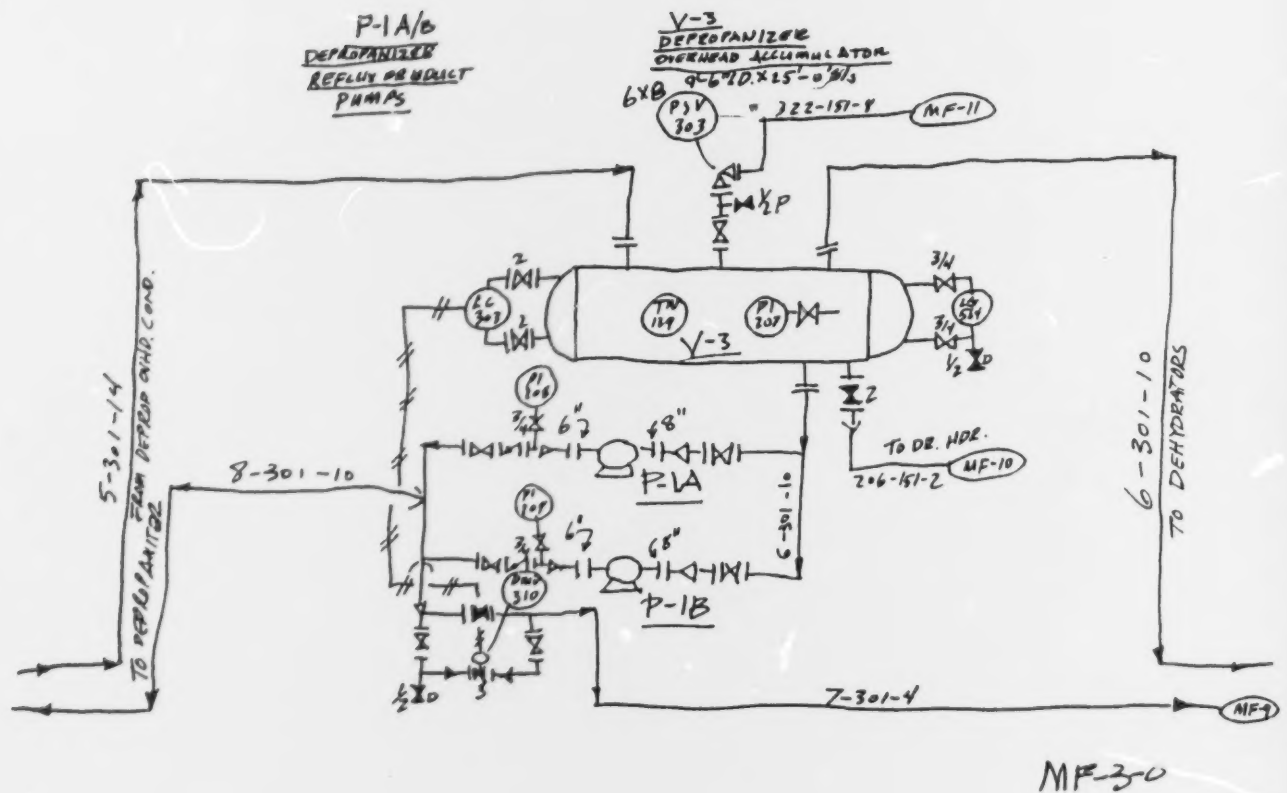
- A. Draw a vertical vessel.
- B. Draw a vertical scrubber.
- C. Draw a horizontal vessel.
- D. Draw a reboiler.
- E. Draw a shell and tube exchanger with valves and instrument symbols.
- F. Draw an inline pump.
- G. Draw a screwed level gage on the vertical vessel.
- H. Draw a flanged level controller on the vertical scrubber.

DRAW A MECHANICAL FLOW DIAGRAM FROM A SKETCH

Directions: Using the following engineer's sketches, draw a mechanical flow diagram.

NOTE: Check with instructor on whether you should draw both or only one.





MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 1: FLOW DIAGRAMS

ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 2: PIPE AND PIPE COMPONENTS

I. Terms and definitions

- A. **Alloy**--a metal that is composed of two or more metals
- B. **Blind flange**--solid plate-like fitting used to seal the end of a flanged end pipe line
- C. **Bonnet**--a metal fitting forged from low carbon steel that is welded to pipe for making a tee, cross, or side outlet
- D. **Components**--standardized fittings and valves manufactured by various companies which are used to assemble a piping system
- E. **Fitting**--any type of pipe connector that is used to change size or direction, to make a connection, or to change the pipe specification from one point to another
- F. **Galvanized**--pipe that has been treated with molten zinc
- G. **Nipple**--any pipe shorter than 12" in length that can be threaded or welded
- H. **Nominal pipe size**--approximate inside diameter of 1/8" to 12" steel pipe, and outside diameter of 14" and larger steel pipe
- I. **Paddle flange**--a blind flange with a handle that is placed between two flanges
- J. **Schedule numbers**--ANSI numbers assigned to pipe depending upon wall thickness
Examples: 40, 80, 160
- K. **Spectacle flange**--double-flange unit that has a blank that can be swiveled to either a closed or open position

NOTE: They are commonly made in a Figure-8 shape.

II. Types of pipe materials

A. Metallic

- 1. Wrought iron and steel

NOTE: Both are commonly used for water, oil, and gas services.

- 2. Galvanized
- 3. Cast iron

NOTE: Cast iron is commonly used for sewage, water, and gas services.

4. Brass-copper
5. Lead

NOTE: Lead resists the chemical action of many acids.

6. Aluminum
7. Stainless steel
8. Alloys

B. Nonmetallic

1. Plastic
2. Glass
3. Clay
4. Wood

III. Pipe size and dimensions

NOTE: Refer to pipe size tables in manuals or handbooks for complete dimensions.

- A. Pipe size is referred to by nominal pipe size.
- B. Steel pipe 14" and above is designated by the actual OD and thickness of pipe walls.
- C. Steel pipe under 14" is designated by the nominal diameter and schedule number.
- D. Pipe is usually supplied at random lengths from 16 to 22 feet.
- E. Pipe may be supplied at double random length from 36 to 40 feet.
- F. Any round tubular products that are not in standard pipe sizes are called tubing.
- G. The ID will vary with the schedule number on all pipe.

IV. Types of pipe fittings and characteristics (TM 5.18)

A. Butt weld

1. Safer and more economical than a flanged joint
2. Have a smoother inner surface and offer uniform wall thickness throughout the piping system for minimum turbulence
3. Easy to insulate
4. Form leak proof connections
5. Not easily dismantled

B. Threaded or screwed

1. Commonly used on low-temperature/low-pressure installations and on small pipes under 2 1/2" in diameter
2. Easy to use in makeup and dismantling
3. Cutting of threads reduces the wall thickness of the pipe and increases the chance of failure

C. Flanged

1. Easily dismantled and assembled
2. Economical when they can be used to eliminate unnecessary welding
3. Considerably heavier than an equally rated butt-welded system
4. More expensive to support from the existing structure because of higher weight load

D. Socket weld

1. Do not require beveled pipe
2. Provide a self-aligning joint

E. Bell and spigot--Used for sanitary sewer lines

F. Special bonnet weld (TM 5.19)

NOTE: They are available in weldolets, threadolets, or sockolets.

1. Used to make 45° and 90° branch pipe outlets
2. Eliminate the preliminary layouts of main branch lines

V. Types of flanges (TMs 5.20 and 5.21)

A. Screwed

B. Weld neck

C. Slip-on

D. Socket weld

E. Lap

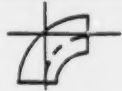
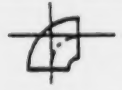
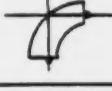
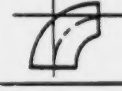
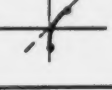
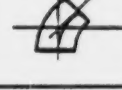
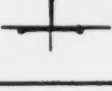
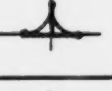
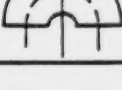
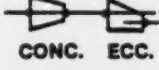
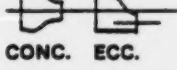
F. Blind

1. "Blank"
2. Spectacle

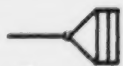
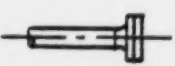
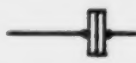
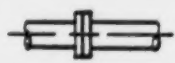
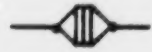
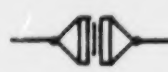
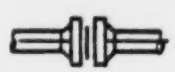
3. Paddle

VI. Welded fitting and flange symbols

A. Fittings

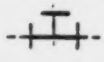
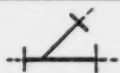
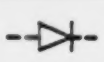
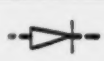
	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1. Elbow, 90° long radius		
2. Elbow, 90° short radius		
3. Elbow, reducing, 90° long radius		
4. Elbow, 45° long radius		
5. Tee, straight		
6. Tee, reducing outlet		
7. Return, 180°		
8. Reducers, concentric and eccentric		
9. Cap		

B. Flanges

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1. Blind		
2. Slip-on		
3. Weld neck		
4. Orifice		

VII. Threaded Fitting Symbols

NOTE: These are also commonly called screwed fittings.

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
A. Elbow, 90°		
B. Elbow, 45°		
C. Elbow, Street		
D. Tee		
E. Cross		
F. Y-Bend, 45°		
G. Coupling, Full		
H. Reducer		
I. Swaged Nipple		
J. Cap		
K. Union		

VIII. Abbreviations

CL or ϵ	Centerline	MI	Malleable Iron
B&S	Bell and Spigot	NPS	Nominal Pipe Size
BC	Bolt Circle	OD	Outside Diameter
BE	Beveled Ends (for welding)	RED	Reducer
BF	Blind Flange	RF	Raised Face
BM or B/M	Bill of Material	RTJ	Ring Type Joint
BOP	Bottom of Pipe	SCH	Schedule
BW	Butt Weld	SCRD	Screwed
CI	Cast Iron	SMLS	Seamless
CONC	Concentric	SO	Slip-On
CPLG	Coupling	SPEC	Specification
CS	Carbon Steel, Cast Steel	SR	Short Radius
DIA	Diameter	SS	Stainless Steel
ECC	Eccentric	STD	Standard
EL or ELEV	Elevation	SW	Socket Weld
FS	Forged Steel	SWG	Swage
FLG	Flange	TE	Threaded End
FOB	Flat on Bottom	TYP	Typical
FW	Field Weld	WE	Weld End
ID	Inside Diameter	WN	Weld Neck
INS	Insulate	WT	Weight
IPS	Iron Pipe Size	w/	With
LR	Long Radius	XS	Extra Strong
		XXS	Double Extra Strong

IX. Drawing pipe and pipe components (TMs 5.22 and 5.23)

A. Drawing pipe

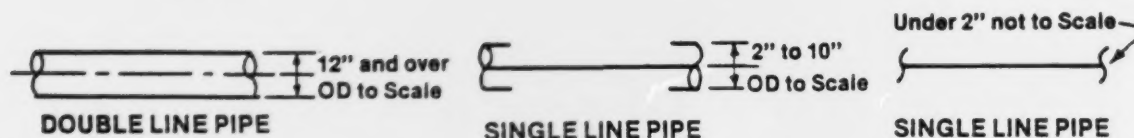
1. Company standards determine whether pipe is to be drawn single line or double line.

NOTE: Normally, pipe that is 2" or larger is drawn double line, but this varies.

2. Pipe break O.D.'s are drawn to scale for pipe that is 2" or larger.

NOTE: Pipe breaks may be drawn freehand or with an ellipse template.

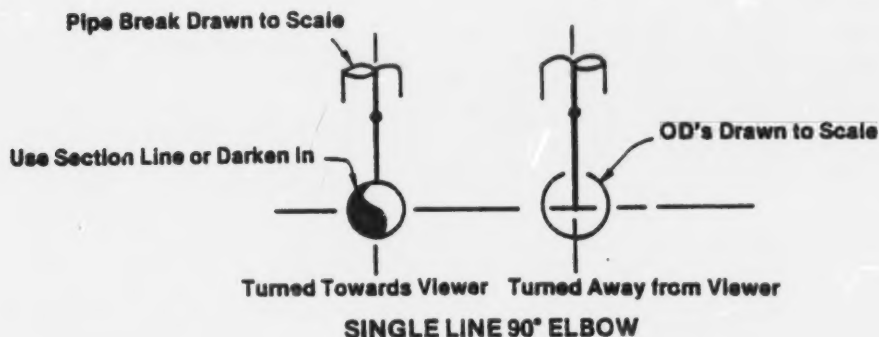
Examples:



B. Drawing pipe components

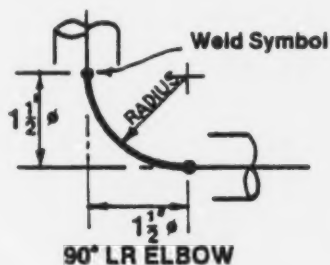
1. Construct nominal pipe size and welding fittings OD to scale in views turned toward and turned away from viewer.

Example:



2. Long radius elbow's radius is $1 \frac{1}{2}$ times the nominal pipe size.

Example:



3. Short radius elbow's radius is equal to the nominal pipe size.
4. 45° elbow's radius is $1 \frac{1}{2}$ times the nominal pipe size.
5. All reducing fittings are drawn double line in single line piping.

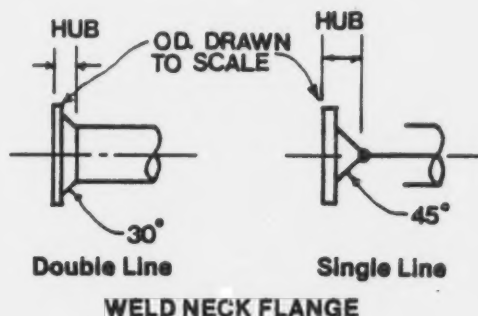
Example:



6. Construct the pipe size and welded fittings to scale in single line or double line.
7. Flange OD is drawn to scale.

8. Hub thickness of a weld neck flange is drawn to scale.

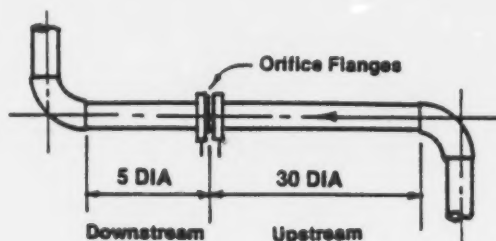
Example:



9. Hash marks for flange face-to-face dimensions, which indicate gasket thickness dimension, may be included.
10. Orifice flanges are commonly drawn 30 diameters upstream and 5 diameters downstream of the flow in pipe from ells, tees, or branch connections.

NOTE: This varies.

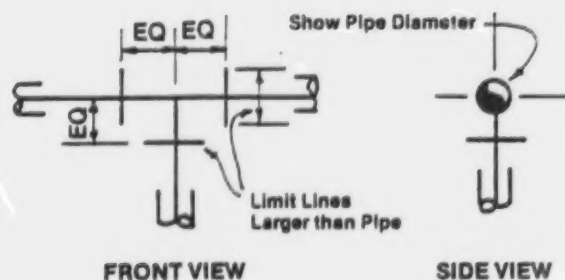
Example:



11. A seamless swage reducer 2" in diameter is 6 1/2" long.
12. A normal swage reducer 2" in diameter is 5 1/2" long.
13. The single line perpendicular to the pipeline shows the screwed socket weld fitting limit.
14. Threads and socket welds are **not** drawn double line in double line drawings.

15. The screwed fitting limit lines are drawn to a scale and slightly longer than pipe diameter.

Example:

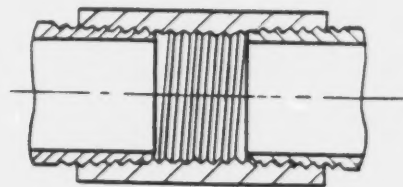


16. For speed while using a template, all welded fittings are drawn double line in single line scaled drawings.
17. Pipelines 12" in diameter and larger are drawn double line to show adequate clearances and pipe size.

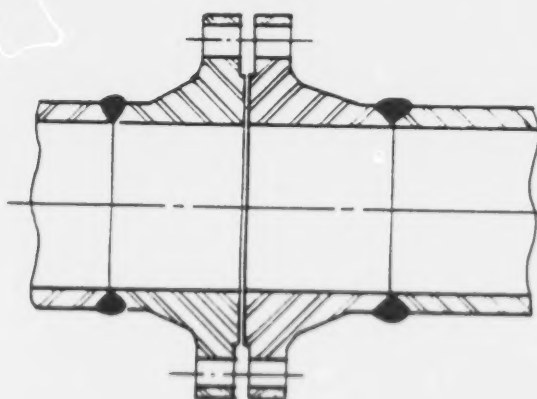
PIPE FITTING CONNECTIONS



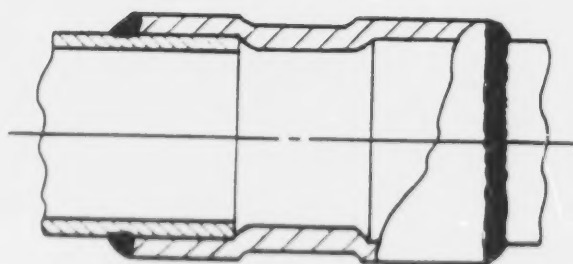
Butt Weld



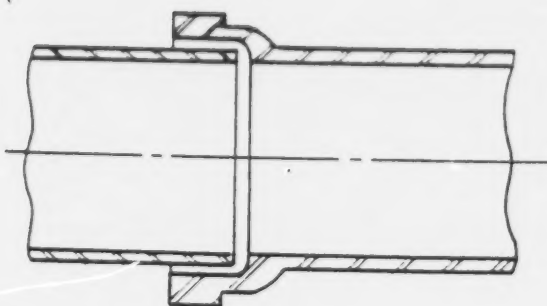
Threaded



Flanged



Socket Weld

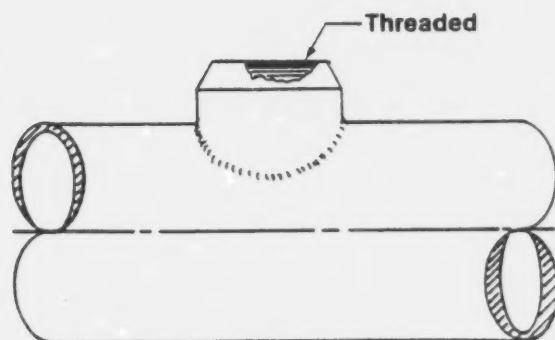


Bell and Spigot

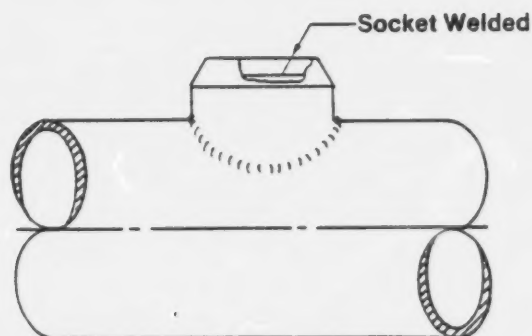


Soldered

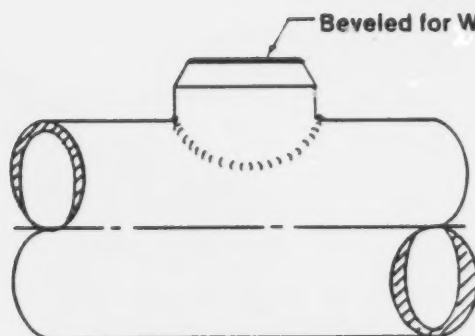
SPECIAL BONNET WELD FITTINGS



Threaded Outlet
(Threadolet)

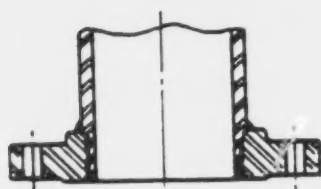
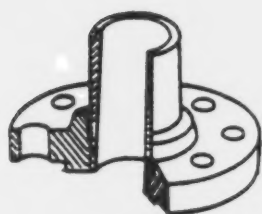


Socket Outlet (Sockolet)

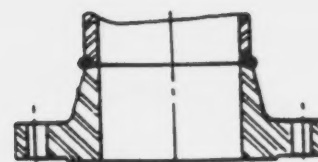
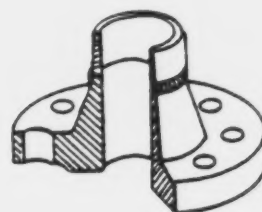


Welding Outlet
(Weldolet)

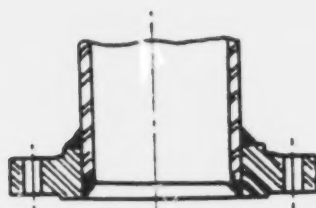
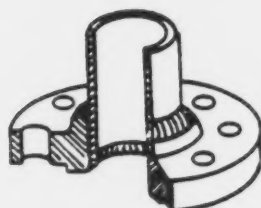
TYPES OF FLANGES



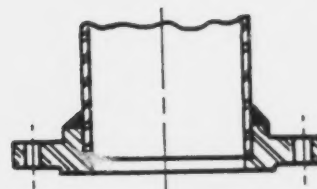
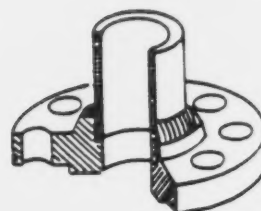
Screwed



Weld Neck

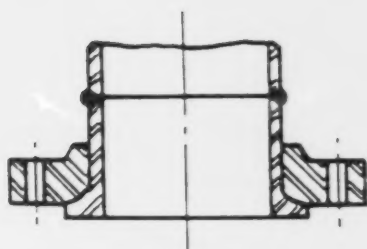
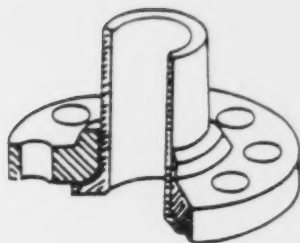


Slip-on

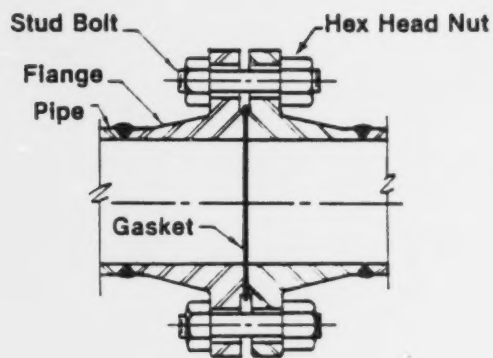


Socket Weld

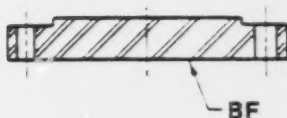
TYPES OF FLANGES (continued)



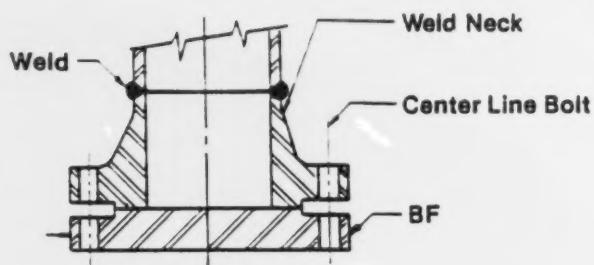
Lap



Flange Fit-up Procedure



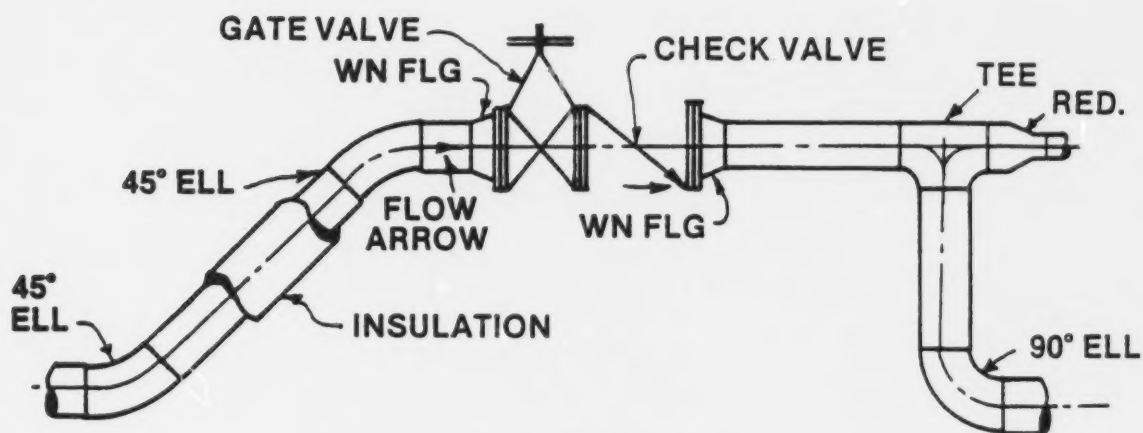
Section Thru
Blind Flanges



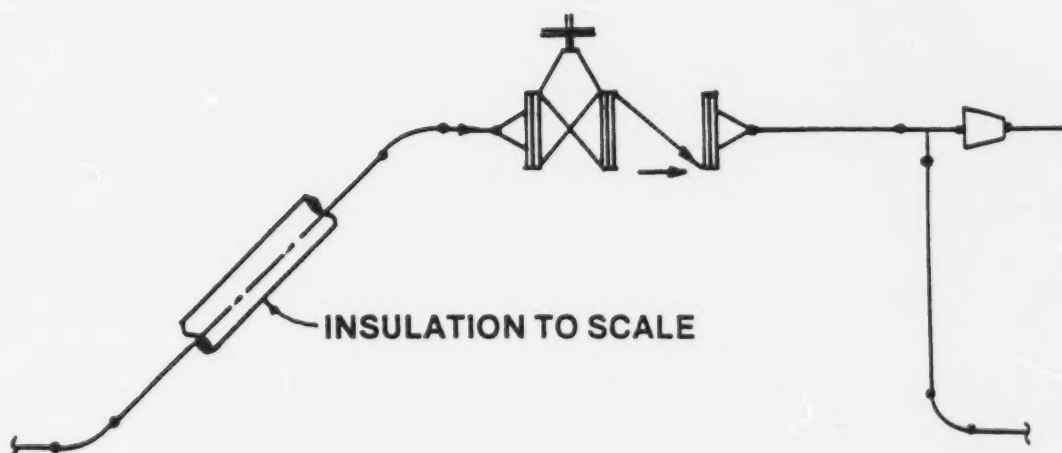
Blind Flange
Assembly

Blind

DRAWING WELDED PIPE COMPONENTS

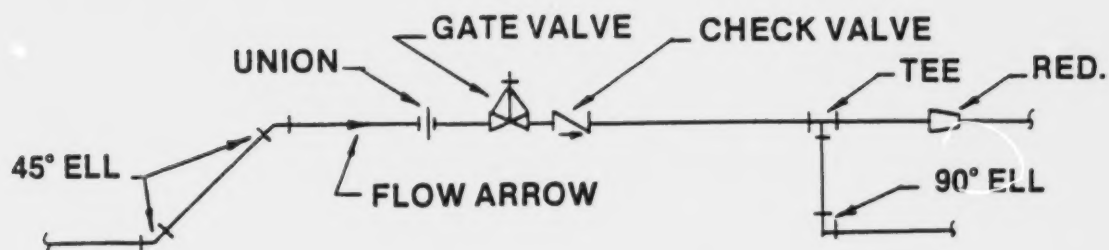


Double Line Butt Weld Pipe and Fittings

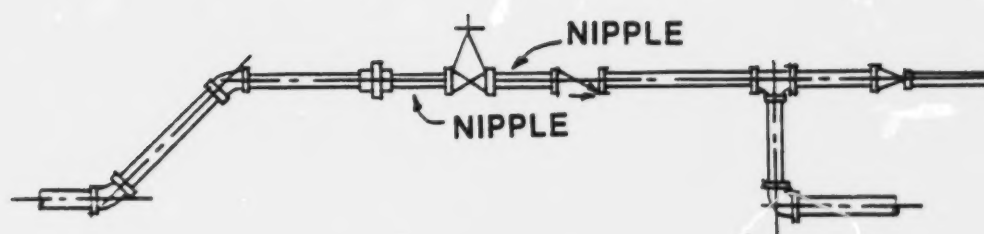


Single Line Butt Weld Pipe and Fittings

DRAWING THREADED PIPE COMPONENTS



Single Line Threaded Pipe



Double Line Threaded Pipe

(NOTE: Pipe 2" and above is usually drawn double line depending on company standards.)

LOOK UP FITTINGS FROM WRITTEN DESCRIPTIONS AND DRAW SYMBOLS

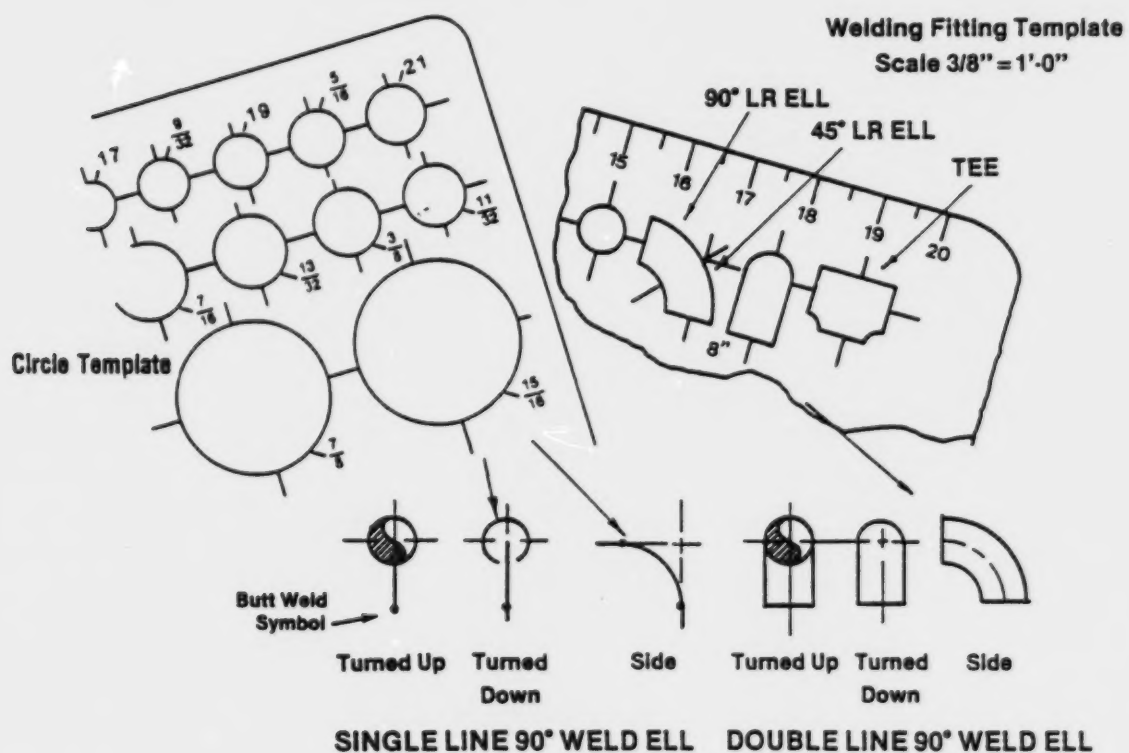
Introduction: When constructing single line symbols, proportional size of screwed or socket fittings is more important than the actual to-scale size of symbols. Throughout industry the symbols are drawn larger and most drafters use a welding fittings template as an aid in drawing single line symbols. On all double line drawings the pipeline and fittings must include a centerline and two outer lines which represent the outside diameter of pipe. The orthographic method is used in drawing views of single line and double line symbols. Use reference materials for determining dimensions needed for drawing symbols. Example A shows how to look up fitting dimensions and Example B shows how to draw symbols using templates.

Example A: Look up dimensions for an 8" nominal pipe size standard weight 90° LR weld elbow.

Answer: We find in a welding fitting dimension table that 8" NPS Std 90° LR WELD ELL has an OD of 8.625" and center-to-face dimension of 12".

Example B: Draw single and double line orthographic symbols for an 8" 90° LR WELD ELL using templates as shown in Figure 1.

FIGURE 1



Directions: Look up the required dimensions for the following fittings using reference materials such as pipe fitters' pocket manuals or Crane Catalogs and place your answers in the blanks provided. Now draw single and double line orthographic symbols in the space provided using templates and the "Fitting Chart" included with this assignment. Use a scale of $\frac{3}{8}" = 1'-0"$ for weld symbols and $1" = 1'-0"$ for threaded or socket weld symbols.

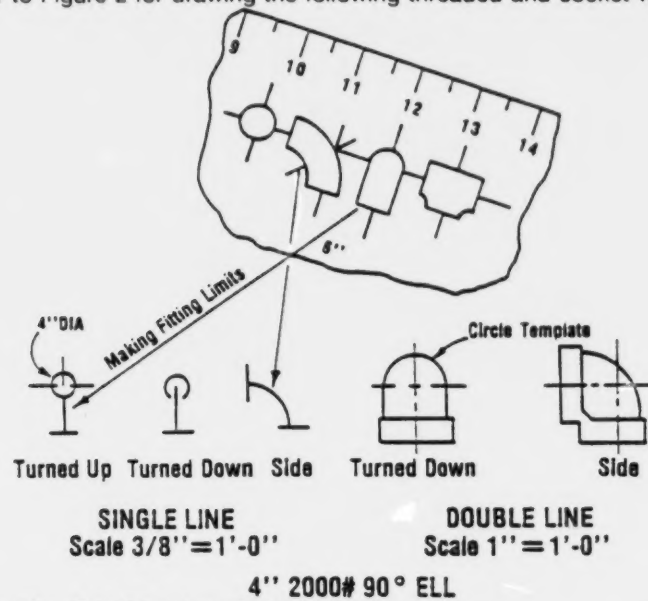
Problems:

- A. Actual OD of 2" nominal pipe size _____
- B. Actual OD of 14" nominal pipe size _____
- C. Actual ID of 1 1/2" schedule 80 pipe _____
- D. "H" dimension of 3 1/2" x 2" STD WT weld concentric reducer _____
- E. Center to face of an 8" x 6" STD WT weld reducing tee _____
- F. Center to face of a 4" STD WT weld tee _____

- G. "E" dimension of a 12" STD WT weld cap _____

NOTE: Refer to Figure 2 for drawing the following threaded and socket weld fittings.

FIGURE 2



- H. "A" dimension of a 2" 2,000# threaded 90° elbow _____

- I. "B" dimension of a 3" 6,000# threaded tee _____

J. "N" dimension of a 1" 3,000# threaded _____
coupling

K. Depth of socket of a 3" 2,000# socket weld 45° _____
elbow

L. "S" dimension of a 2 1/2" 6,000# socket weld _____
coupling

M. Length through hub including raised face of a _____
10" 600# weld neck flange

N. OD of 6" 300# slip-on welding flange _____

O. "Y" dimension of an 8" 150# WN FLG _____

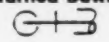
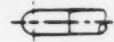
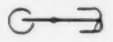
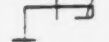
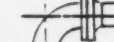
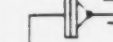
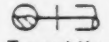
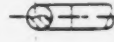
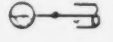
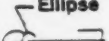
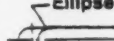
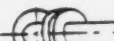
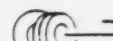
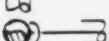
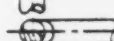
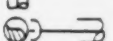
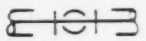
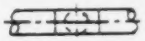
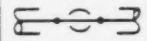
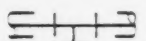
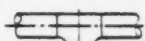
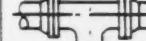
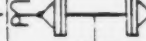
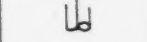
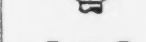
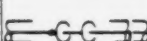
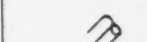
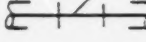
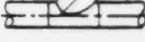
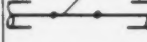
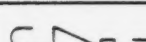
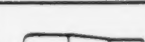
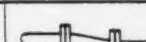
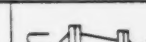
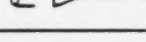
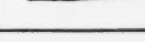
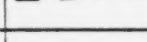
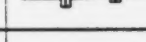
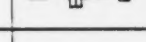
200

P. "A" dimension of a 6" SR 90° ELL _____

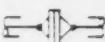
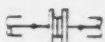
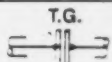
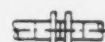
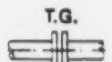
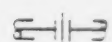
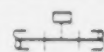
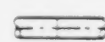
Q. Draw single line and double line symbols only for the following fittings and show weld symbol on single line symbols.

1. 6" weld tee
2. 10" 300# WN FLG
3. 3" 2,000# 90° ELL
4. 3" 6,000# 45° SW ELL

FITTING CHART

		Screwed or Socket Weld Single Line	Welded		Flanged	
			Double Line	Single Line	Double Line	Single Line
90° ELL	TOP	Turned Down 				
	FRONT					
	BOTTOM	Turned Up 				
45° ELL	TOP	Ellipse 	Ellipse 			
	FRONT					
	BOTTOM					
TEE	TOP					
	FRONT					
	BOTTOM					
LATERALS	TOP					
	FRONT					
	BOTTOM					
REDUCERS	CONC.					
	ECC.					

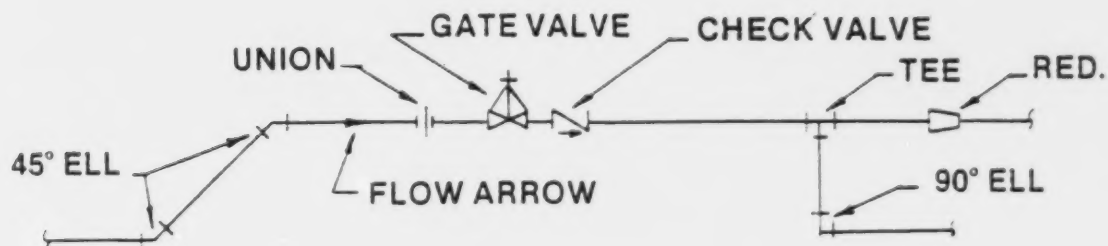
FITTING CHART
(Continued)

FLANGES	SINGLE LINE						
	DOUBLE LINE						
		SLIP-ON	WELD NECK	LAPPED	TONGUE & GROOVE	ORIFICE	BLIND
MISCELLANEOUS	SINGLE LINE			 Screwed			
	DOUBLE LINE			 Welded			
		STUB IN	PIPE WELD	PIPE CAP	UNION	PLUG	WELD SADDLE

CONSTRUCT DOUBLE LINE DRAWING OF WELDED PIPE FITTINGS

Introduction: Double line symbols are used on scale drawings to show exact relationship between lines and equipment.

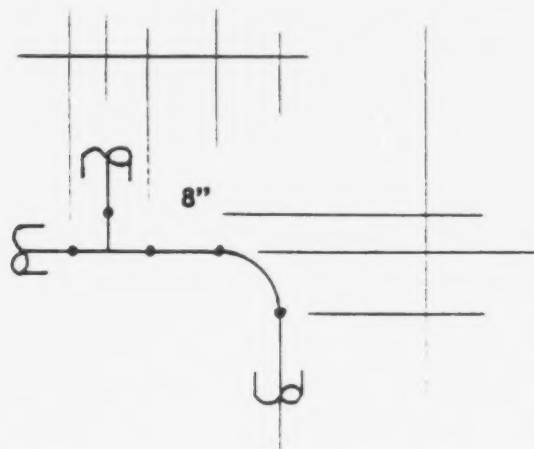
Directions: Construct a double line drawing from the figure below. Draw on "A" size vellum using a scale of $\frac{3}{8}" = 1'-0"$.



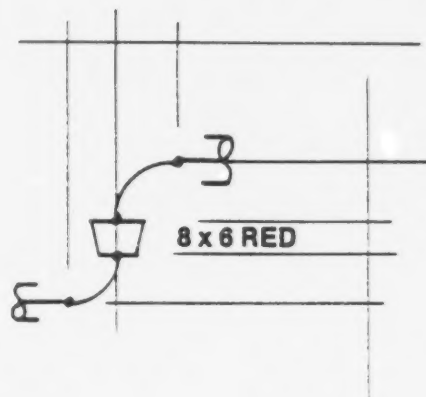
CONSTRUCT SINGLE LINE DRAWINGS OF WELDED PIPE FITTINGS

Directions to be given by instructor.

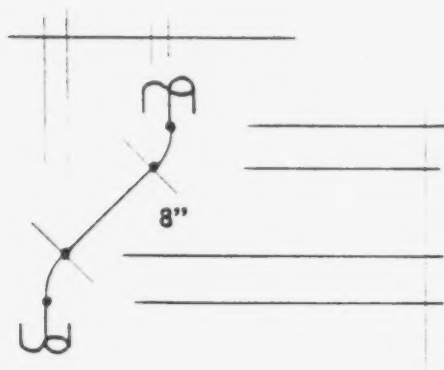
A.



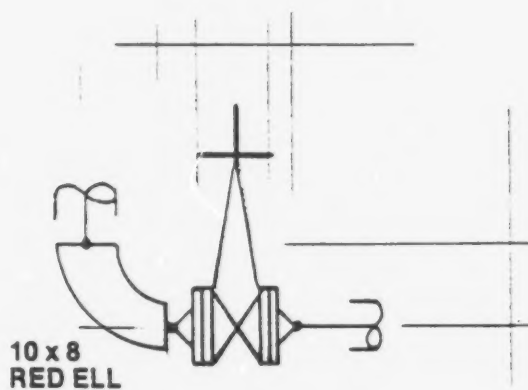
B.



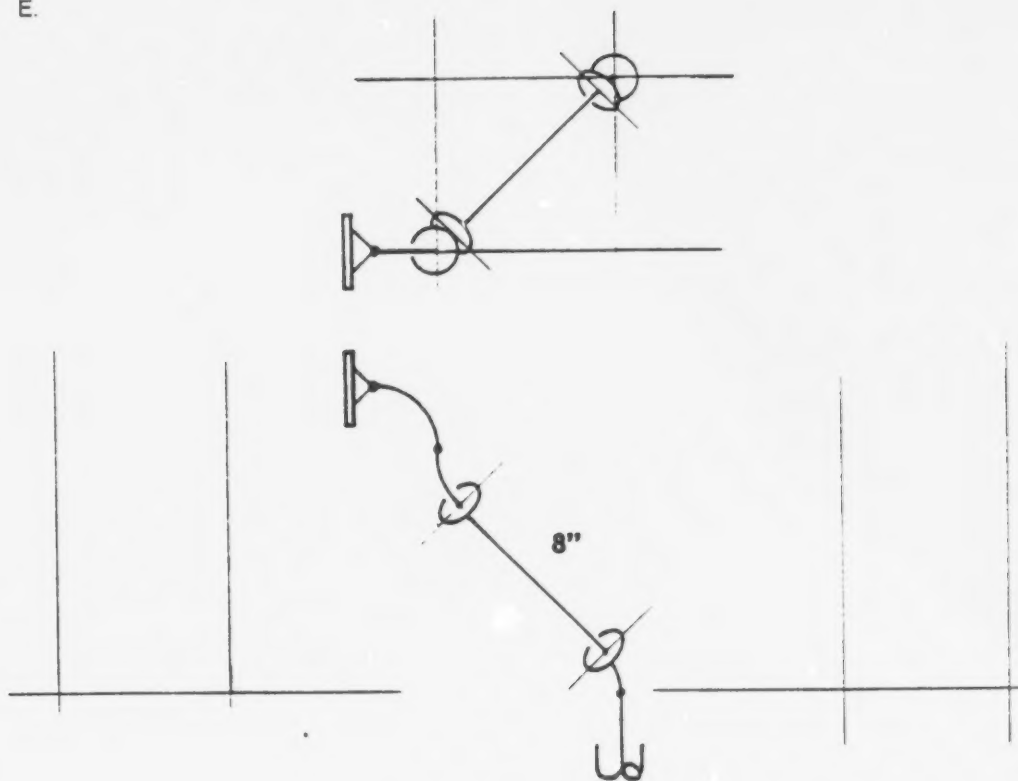
C.



D.



E.



MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 2: PIPE AND PIPE COMPONENTS

ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 3: PIPE DRAFTING STANDARDS

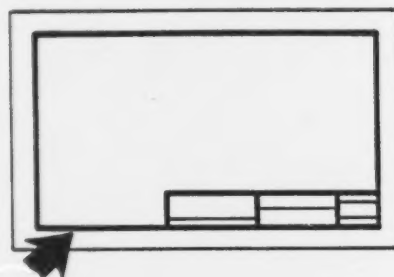
I. Terms and definitions

- A. **Code**--systematic regulatory statements approved by a committee that are published for manufacturing control and use by the public
- B. **Coordinate locations**--points on a plan drawing found using N/S or E/W dimensions from a reference point
- C. **Instrumentation**--devices used to control and/or indicate temperature, pressure, level, and flow in pipe or equipment in order to keep a system working efficiently and within required specifications
- D. **Pipe drafting**--the field dealing with the drawing of pipe, pipe components, equipment, and structures and the layout of these items in a functional arrangement
- E. **Process flow**--the path of a product being made or refined shown on a schematic
- F. **Schematic**--any line drawing which illustrates the arrangement and relationship of the parts
- G. **Standard**--specification, test method, definition, classification, publication, or practice that has been approved by a committee to regulate or control manufacturing

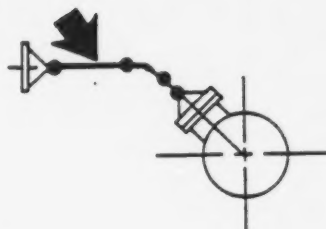
II. Types of lines

NOTE: It is important to draw lines their proper thicknesses in order to show the relationship between piping and equipment. Since there are many lines on a piping plan, contrasts must be shown by emphasizing with darker lines those areas that need to stand out. Appropriate thicknesses for the following lines are shown in parentheses.

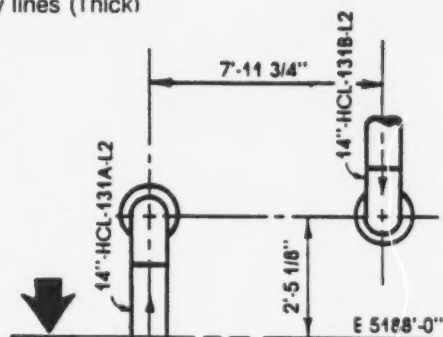
- A. Border lines (Extra thick)



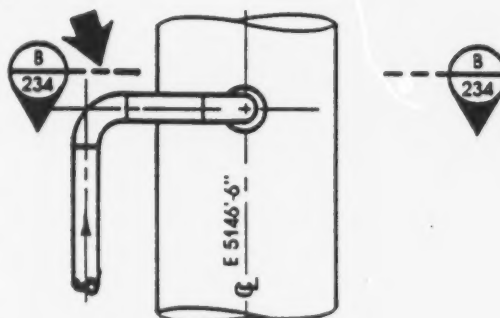
B. Pipe lines (Thick)



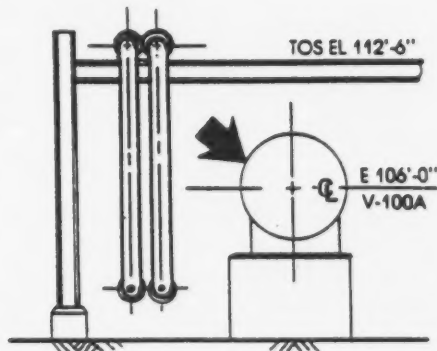
C. Match and boundary lines (Thick)



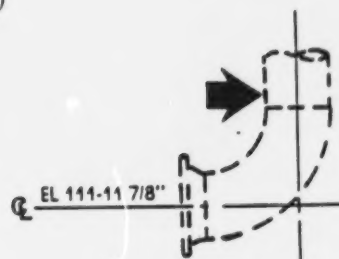
D. Cutting plane lines (Thick)



E. Equipment and structural lines (Thin light)

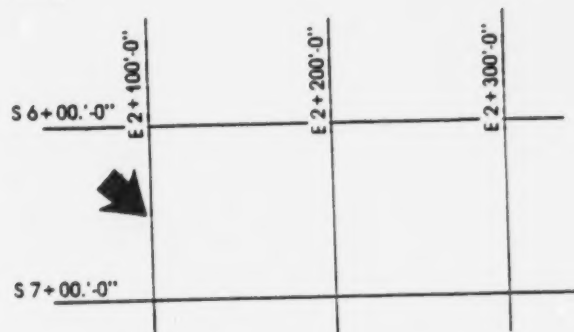


F. Hidden lines (Thin dark)

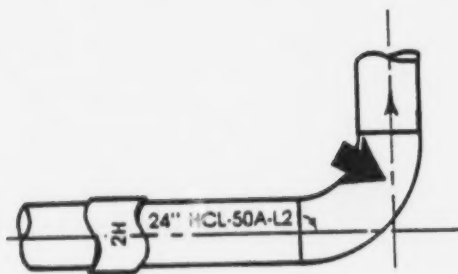


NOTE: Hidden lines are also used for existing equipment and under-ground lines.

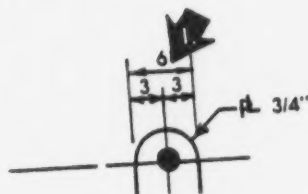
G. Coordinate lines (Thin dark)



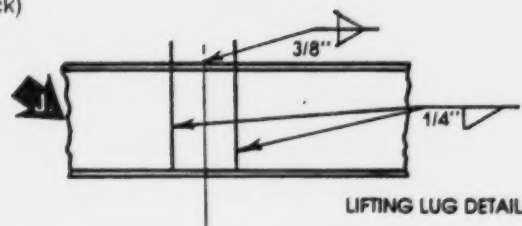
H. Center lines (Thin dark)



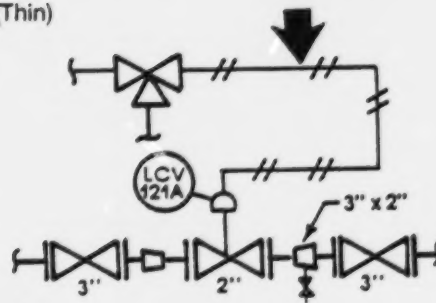
I. Dimension lines (Thin dark)



- J. Break lines (Thick)



- K. Instrument air lines (Thin)



III. Working drawings and definitions

- A. Mechanical flow diagram--a single line schematic that is drawn with no scale and includes the process flow, major equipment, instrumentation, major valves, and line sizes, pressures, and temperatures
- B. Plot plan and equipment layout--drawing using information taken from site plan for the purpose of drawing to a scale of 1" = 20'-0" or 1" = 10'-0" the layout of buildings, equipment, and any physical information needed for design and construction of the piping system
- C. Piping plans--views of piping drawn to a scale of 3/8" = 1'-0" that show line sizes, flow direction, coordinate locations, basic horizontal overall dimensions, match lines, equipment identifications, line specification numbers, sectional-view references, or material call-outs
- D. Elevations--sectional views drawn to varying scales that show line sizes, vertical dimensions, coordinate locations, equipment identifications, line specification numbers, and elevation dimensions
- E. Isometrics--single or double line views not drawn to scale which show components, valves, fittings, dimensions, notes, and a bill of materials
- F. Special fabrication details--views usually drawn to a scale of 1/2", 1", or 1 1/2" = 1'-0" which show details of special pipe fabrication, pipe supports, and structural piping

IV. Common types of templates (TMs 5.24 and 5.25)

- A. Flow

NOTE: This is used for single line pipe layout and on process and mechanical flow diagrams.

- B. Circle

NOTE: This is used to construct equipment outlines and sectional views of pipe.

- C. Isometric ellipse

NOTE: This is used to construct isometric views of pipe and pipe joints.

- D. Instrument symbols

NOTE: This is used on mechanical flow diagrams and instrument drawings.

- E. Flanged valves

NOTE: This is used to construct light and heavy flanged valves according to ANSI B-16.10 Valve Standards.

- F. Pipe fitting

NOTE: This is used to construct welded pipe fittings on plan and elevation drawings.

- G. Isometric piping

NOTE: This is used to construct piping components and fittings on isometric drawings.

V. Piping standards and their purposes

- A. ANSI (American National Standards Institute)--Organization which provides services to industry including the standardization of different codes for piping, design, and dimensional properties

NOTE: A.S.A., "American Standards Association," was formed in 1918, reorganized as USAS, "United States of America Standards Institute," in 1966, and then changed its name in 1969 to ANSI.

- B. ASME (American Society of Mechanical Engineers)--a non-profit national technical society which promotes engineering, standardizes different codes, and disseminates technical information of pertinent interest resulting in publication of these codes

- C. ASTM (American Society for Testing and Materials)--A non-profit national technical society which promotes the materials of engineering and standardizes specifications and the methods of testing

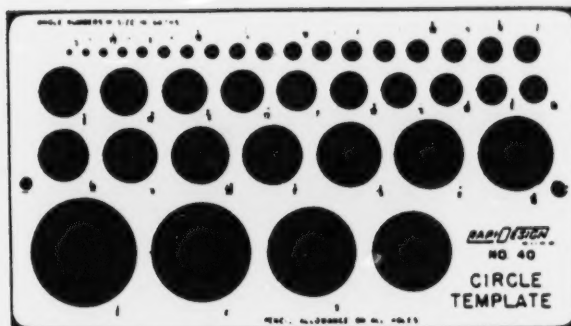
- D. AWWA (American Water Works Association)--a non-profit national technical society which promotes water works piping or pipe fittings and standardizes specifications

- E. MSS (Manufacturers Standardization Society of the Valve and Fitting Industry)--A non-profit national technical society which promotes standardization in manufacturing of valves and fittings

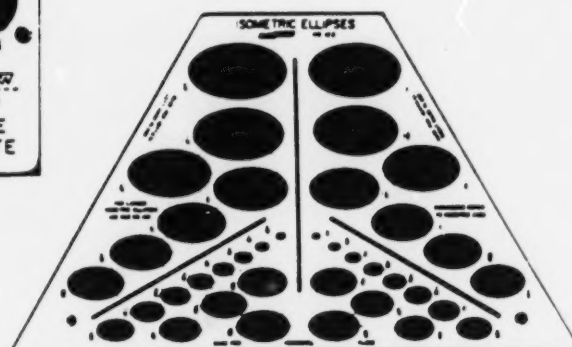
- F. PFI (Pipe Fabrication Institute)--a non-profit national technical society which promotes the standardization of pipe fabrication, establishes limits of responsibility, and fixes tolerances

- G. API (American Petroleum Institute)--a non-profit national technical society which promotes standardization of specifications, materials, fabrication methods, testing, and uses in the petroleum industry

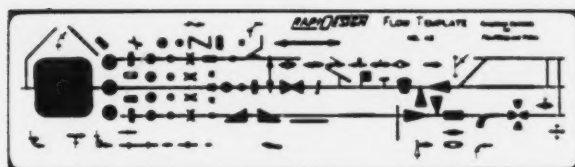
TYPES OF TEMPLATES



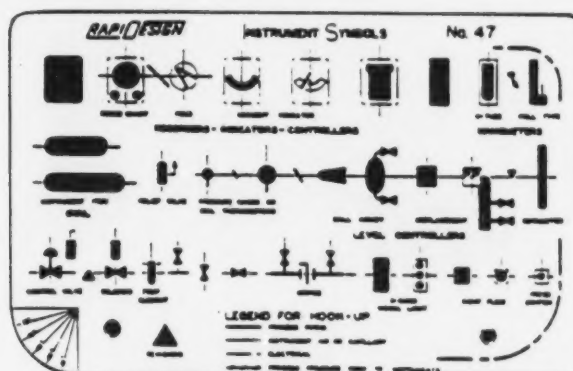
Circle



Isometric
Ellipse

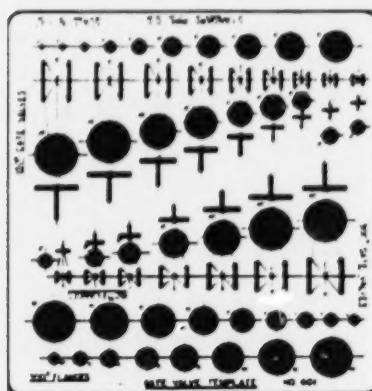


Flow

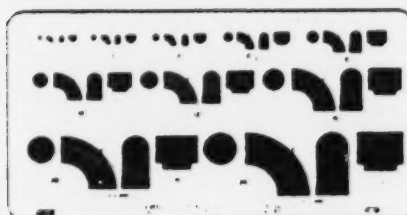


Instrument Symbols

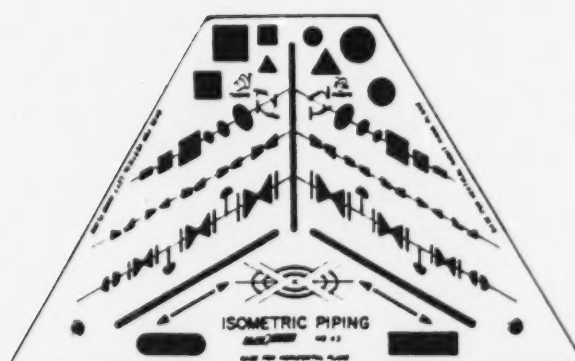
TYPES OF TEMPLATES (continued)



Flanged Valves



Pipe Fitting



Isometric Piping

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 4: ISOMETRIC PIPE DRAWINGS

I. Terms and definitions

- A. **Dummy support**--support which helps carry some weight of the line, but which doesn't affect the process flow
- B. **Field weld**--the joining of two pieces of metal made on the site by the construction crew
- C. **Hydrostatic testing**--putting water inside pipe under a certain pressure for a short time to find out if there are any flaws in the pipe

NOTE: This is done on a line before it is put in service.

- D. **Hypotenuse**--the side of a right triangle that is opposite the right angle
- E. **Mark number**--a mark used to identify something in a numerical sequence
- F. **Shop weld**--the joining of two pieces of metal in a fabrication establishment (shop)
- G. **Spool drawing**--drawing used in industry to call out and dimension a pipeline unit for fabrication
- H. **Stress relieving**--reducing the stress in the metal with heat where a weld has been made

NOTE: This is similar to the relaxing of a muscle.

- I. **Tallying**--calculating the total number
- J. **Trigonometric function**--a function of an arc or angle expressed as a ratio of pairs of sides of a right triangle

Examples: Sine, Cosine

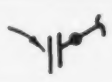
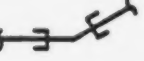
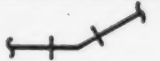
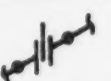
- K. **Trigonometry**--the study of the properties of triangles and trigonometric functions and their applications
- L. **X-ray**--a special photo taken to examine what the inside of a weld looks like

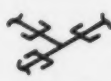
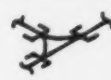
II. Purposes of isometrics

- A. For detailing and dimensioning of piping
- B. For ordering final tally parts
- C. For flagging special components
- D. For supplying piping fabrication notes to fabricators

- E. For shop fabrication
 - F. For piping installation by field crews
 - G. For a better understanding by all personnel
- III. Information on the drawing side of an isometric (TM 5.26)
- A. Single line pipe
 - B. All fitting symbols
 - C. All equipment item numbers and titles
 - D. All centerline to centerline dimensions
 - E. All centerline to face dimensions
 - F. All face to face dimensions
 - G. All instrumentation balloons with numbers
 - H. Special fitting balloons
 - I. All connecting line numbers
 - J. North arrow
 - K. Pipe size
 - L. One centerline elevation
 - M. Flow direction
 - N. Shop welds
 - O. Field welds
 - P. Shop and field erection marks (spool marks)
 - Q. Dummy supports
 - R. Vents and drains

IV. Single line isometric symbols

Fitting	Symbol	Fitting	Symbol
FLANGE, WN		CAP, WELDED	
FLANGE, SO		CAP, SW	
FLANGE, SW		CAP, SCRD	
FLANGE, SCRD		WELD-O-LET	
FLANGE, BLD		SOCKET-O-LET	
ELBOW, 90°		ELBOW-O-LET	
ELBOW, 90° RED		CPLG, SW	
ELBOW, 90° SW		CPLG, THREADED	
ELBOW, 90° SCRD		PLUG, SCRD	
ELBOW, 45°		DRESSER CPLG	
ELBOW, 45° SW		ORIFICE, SCRD	
ELBOW, 45° SCRD		ORIFICE, FLGD	

Fitting	Symbol	Fitting	Symbol
TEE, BUTT WELD		GATE VA	
TEE, RED		BALL VA	
TEE, SW		GLOBE VA	
TEE, SW RED		CHECK VA	
TEE, SCRD		PLUG VA	
TEE, SCRD RED		ANGLE VA	
RED, CONC		RELIEF VA	
RED, ECC		CONTROL VA	
SWAGE		BUTTERFLY VA	
UNION			

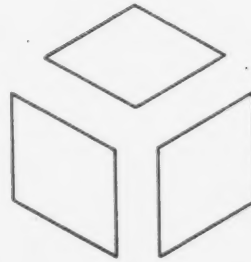
V. Isometric fitting representation

A. There are three main planes in isometric drawing.

1. Vertical left
2. Vertical right

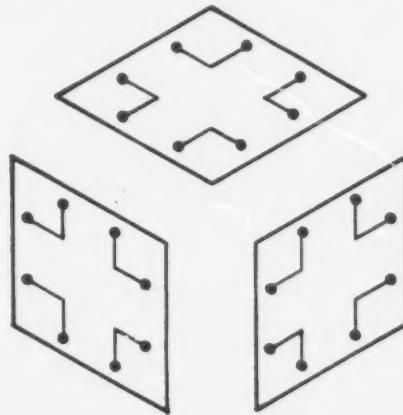
3. Horizontal

Example:



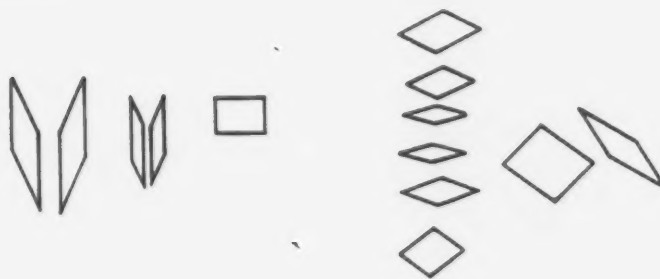
B. Each fitting has four main representations in each plane.

Example: For a butt welded 90° long radius elbow



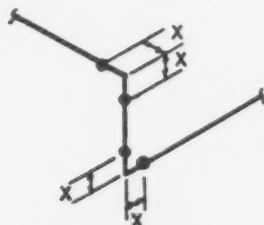
C. There can be an infinite number of supplementary planes.

Example:

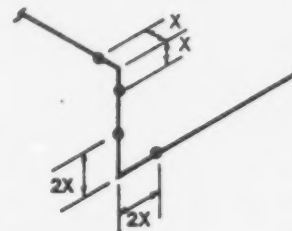


- D. Fittings are not drawn to scale but are drawn as close to actual representation as possible.
- E. If a fitting is drawn on a drawing more than once, the size should not be changed.

Example:



CORRECT



INCORRECT

- F. Any special fitting that there isn't a symbol for, a new symbol will be made and noted in a legend.

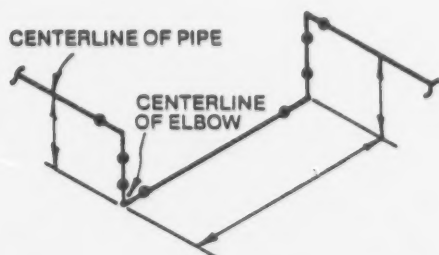
VI. Drawing equipment on isometrics

- A. All manufactured equipment is shown on the isometric drawing as hidden lines or thin lines.
- B. Only a small part of the manufactured equipment is shown.
- C. The item number and equipment title are shown inside the hidden lines.

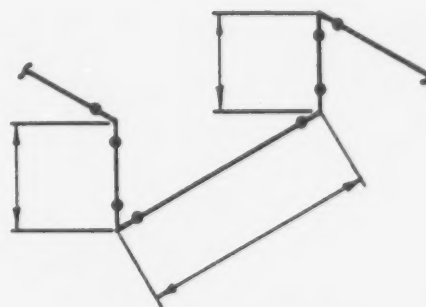
VII. Procedures for drawing isometrics

NOTE: Remember, isometrics are drawn on 30° and 120° axes only.

- A. Dimensions are from centerline to centerline.

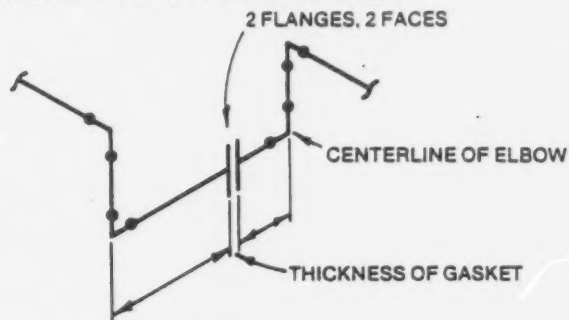


CORRECT

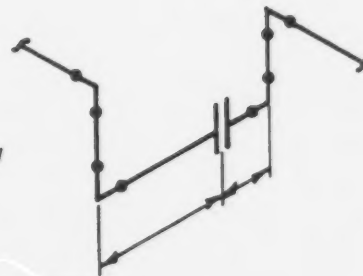


INCORRECT--Dimension lines not in correct planes

- B. Dimensions are from centerline to face.

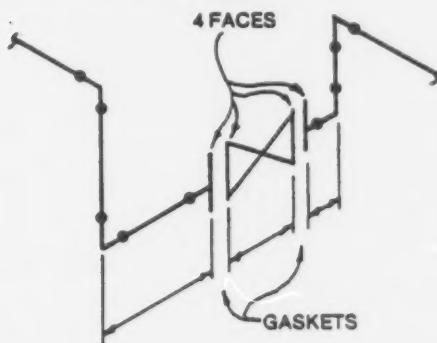


CORRECT

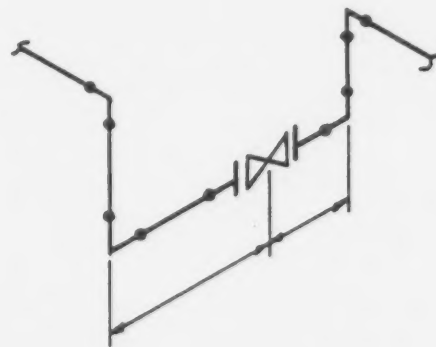


INCORRECT—Not to face

- C. Dimensions are from face to face.

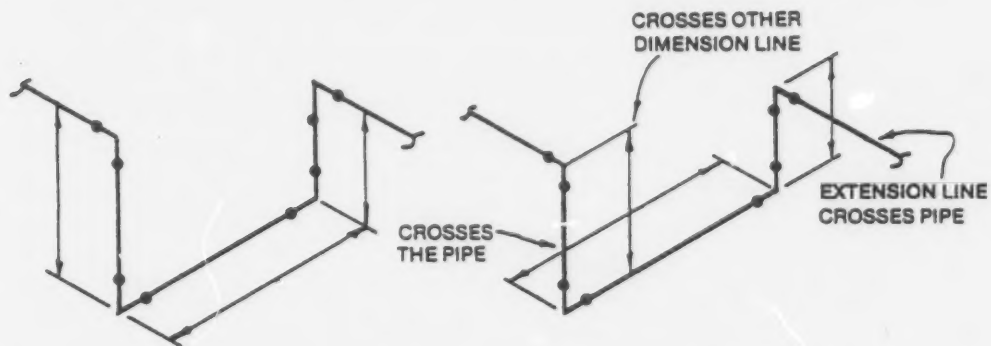


CORRECT



INCORRECT

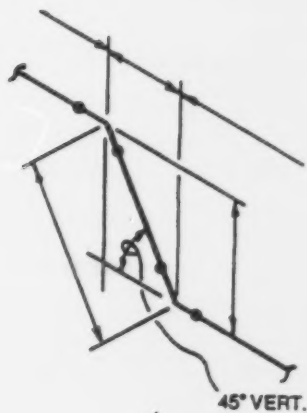
- D. Dimension lines should not cross pipe, other dimension lines, or extension lines.



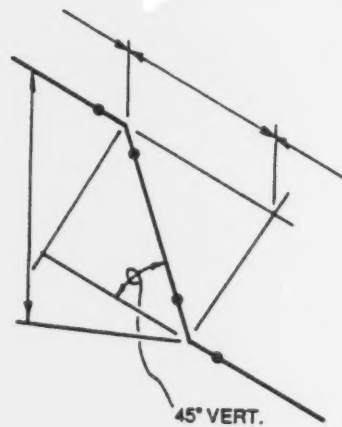
CORRECT

INCORRECT

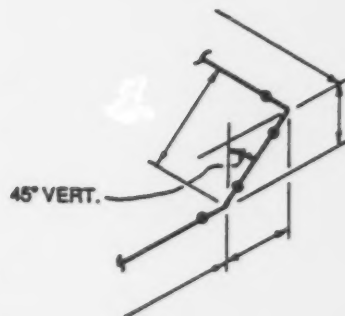
E. Dimensioning angle offsets



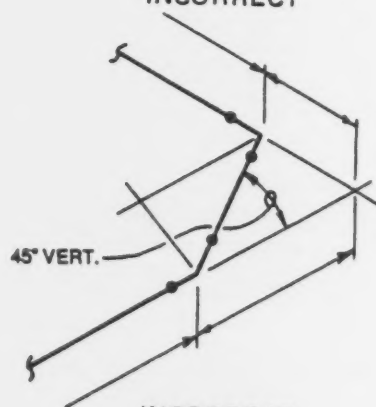
CORRECT



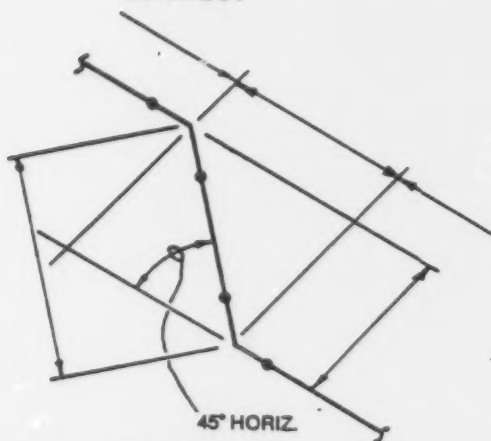
INCORRECT



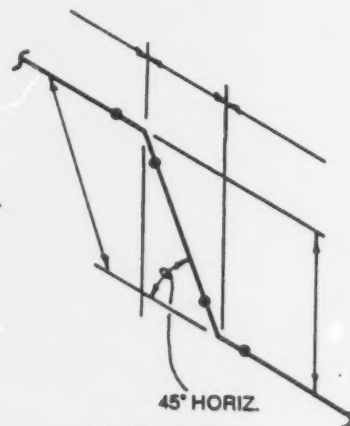
CORRECT



INCORRECT

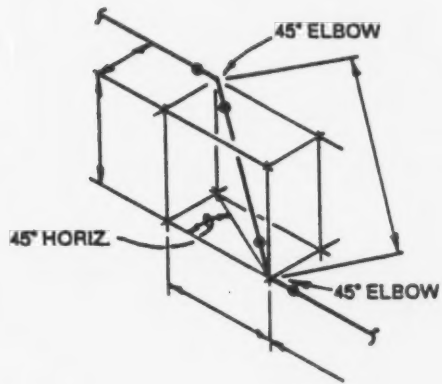


CORRECT

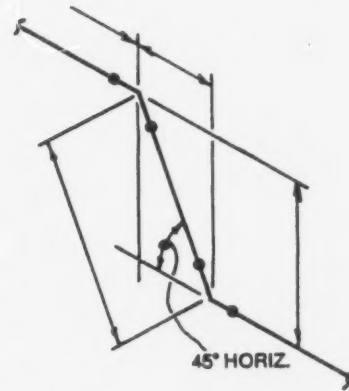


INCORRECT

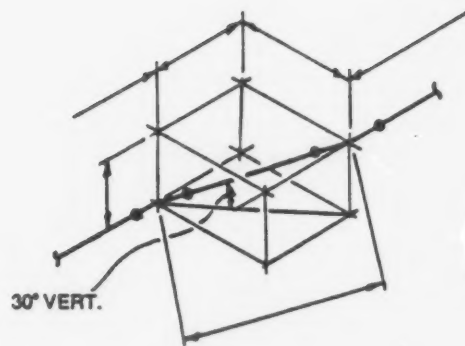
F. Dimensioning rolled offsets



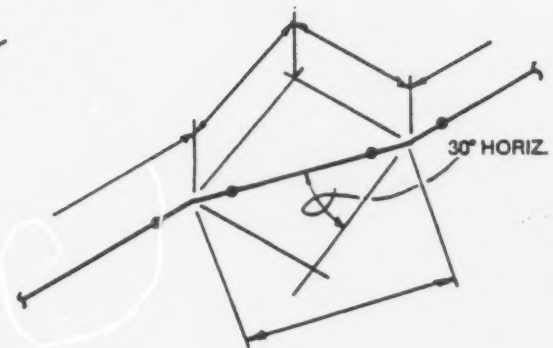
CORRECT



INCORRECT

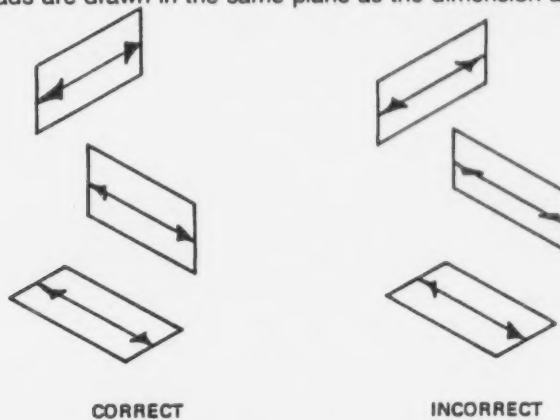


CORRECT

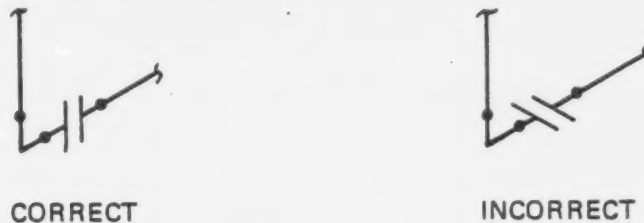


INCORRECT

- G. Arrowheads are drawn in the same plane as the dimension and extension line.



- H. Flange symbols should be parallel with flow line



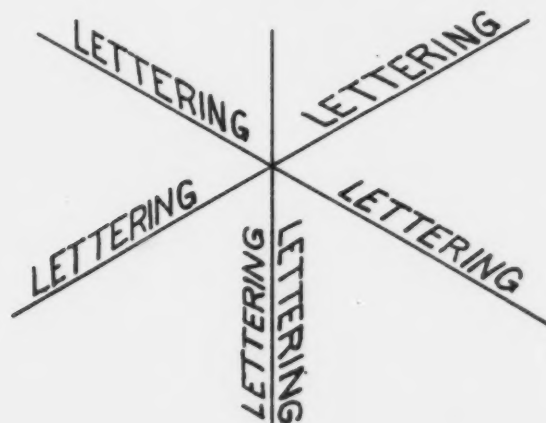
- I. Dimension lines are in line with flanges.



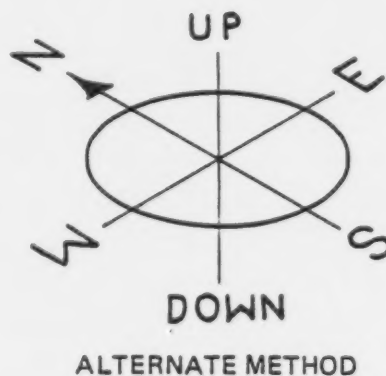
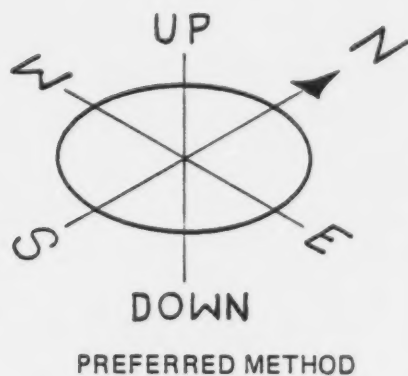
VIII. Lettering correctly in various planes

- A. Isometric lettering is vertical style lettering that is slanted in the plane that it is in.

- B. Isometric lettering should be done as shown in the following illustration.



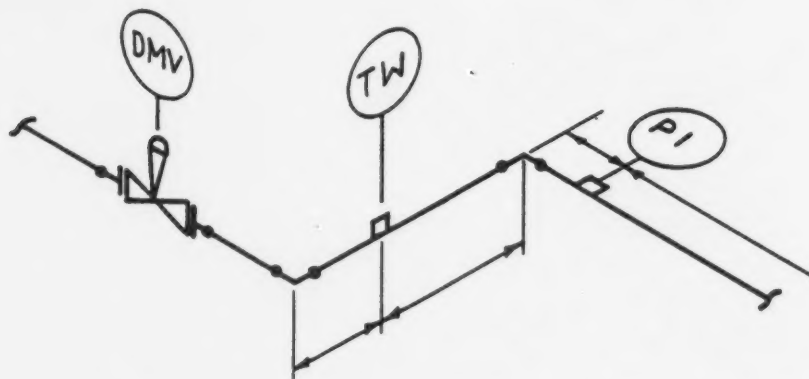
- C. Any standard vertical style lettering on an isometric drawing indicates some type of note
- IX. Drawing and placing a north arrow
- A. All piping isometrics have a north arrow to show the direction a line is traveling in relationship to north.
- B. North arrows may be drawn by the preferred method or alternate method.



- C. The north arrow is placed in the upper right hand corner on the drawing side.
- X. Drawing and lettering an instrumentation balloon

- A. Balloons are used to call out instrumentation.

Example:



- B. A 7/16" diameter isometric ellipse template is used.

- C. Lettering should be in correct plane.

- D. The balloon may be opened for lettering.

Example:



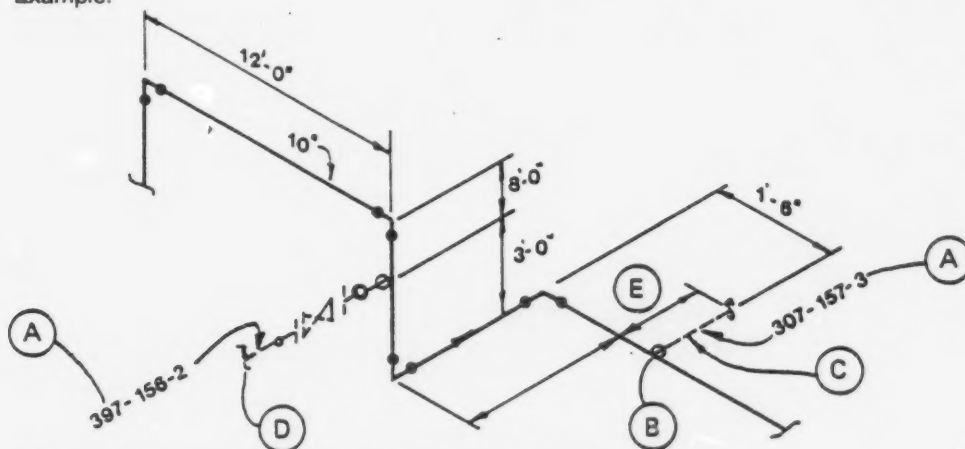
XI. Special ballooning

- A. Special ballooning is used for special fittings on an isometric.
- B. The number in the balloon will correspond to the mark number in the bill of material section.
- C. If balloons are put on all fittings and valves, the drawing will be very cluttered.

XII. Connecting lines and numbers

- A. Connecting line numbers should be called out in full; this is to help in finding what line connects to it.

Example:



- B. Where the line connects to another line, draw the weld dot open.
- C. Connecting lines are drawn as hidden lines.
- D. Lines should only be broken on pipe, never on fittings or valves.
- E. Connecting lines are not dimensioned.

XIII. Characteristics of vents and drains

- A. A vent coupling is put in all high points of a line.
- B. A drain coupling is put in all low points of a line.

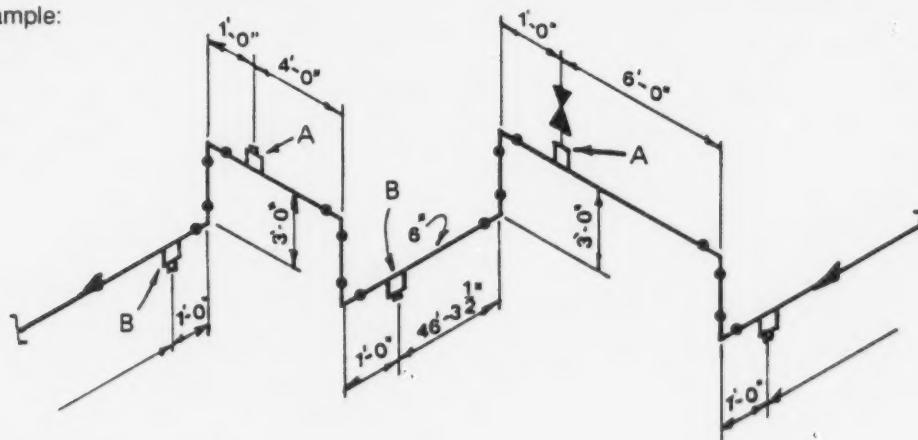
NOTE: These couplings may either have a plug or a valve screwed into them according to customer preference.

- C. The vent is used to let air out when filling up the line.

- D. The drain is used to let water out of the line after testing.

NOTE: Vents and drains may also be used as needed after the line is in service.

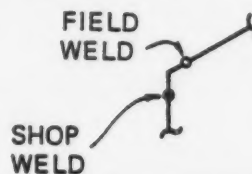
Example:



XIV. Shop and field erection marks

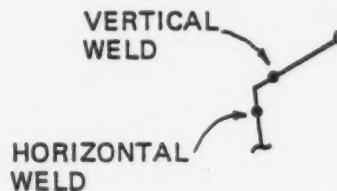
- A. Shop and field erection marks are placed in rectangular boxes on the isometric with leader lines.
- B. The mark number has two numbers--the first number is the line number, the second is the piece number.
- C. Each mark number is now called a spool.
- D. In order to be moved to the site, all pieces must fit on a truck float which is 8' x 40'.
- E. No piece can be bigger than 8' wide, 40' long, and 8' high.
- F. A closed weld dot is a shop weld.
- G. An open weld dot is a field weld.

Example:



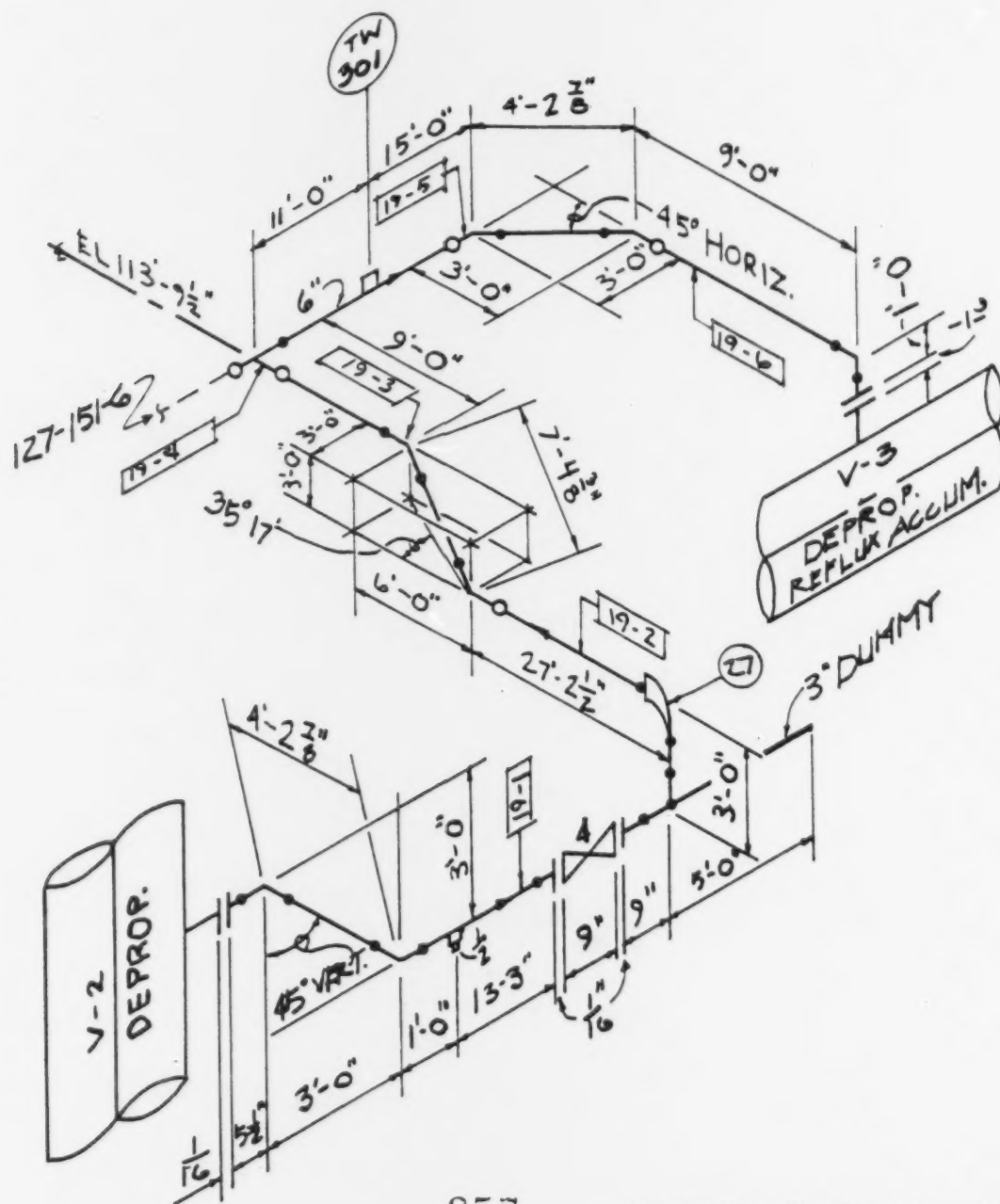
- H. In placing field welds on isometrics, try not to have any horizontal welds.

Example:



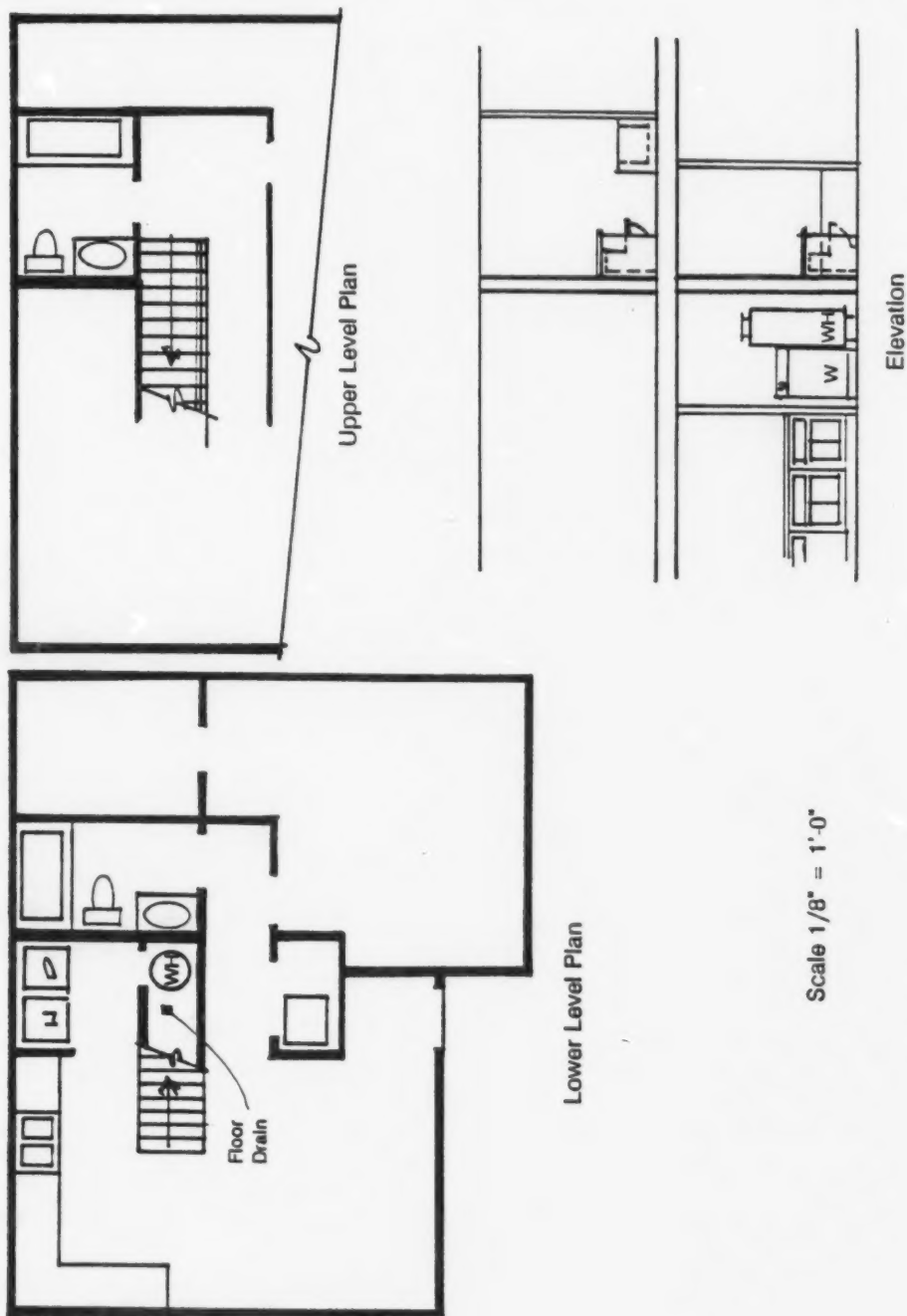
ISOMETRIC DRAWING

NOTE: DIMENSIONS ARE TO CENTERLINES UNLESS OTHERWISE NOTED.



MAKE A SINGLE LINE ISOMETRIC DRAWING

Directions: Draw isometric plumbing riser. Show vents, water lines, and sewer connection.



Courtesy of Hulen & Hulen, Columbia, MO

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

LESSON 4: ISOMETRIC PIPE DRAWINGS

ANSWERS TO ASSIGNMENT SHEET

Answer to the assignment sheet should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

UNIT TEST

Lesson 1

Match the terms on the right with one correct definition on the left.

- | | | |
|---------|--|----------------------|
| ___ 1. | Any line drawing which illustrates the arrangement and relationship of the parts | a. Flow diagram |
| ___ 2. | A schematic diagram not drawn to scale that shows direction of flow on lines and equipment, and indicates size, temperature, pressure, and flow rate | b. Flange |
| ___ 3. | A device installed in a flow line to stop or control temperature, pressure, or flow rate | c. Schematic diagram |
| ___ 4. | A method of joining pipe components and equipment for later dismantling and maintenance of equipment | d. Equipment |
| ___ 5. | Solid plate-like fitting used to seal the end of a flanged-end pipeline | e. Valve |
| ___ 6. | A tubular or cylindrical shape used for transporting gases, liquid, or fine solids or for structural support | ab. Reducer |
| ___ 7. | A pipe fitting used to reduce or enlarge a pipe to a different size | ac. Blind flange |
| ___ 8. | Material used on the outside of pipe or equipment to keep temperature constant and to protect personnel | ad. Weld cap |
| ___ 9. | Bowl-shaped component welded to an open end of pipe to stop flow | ae. Insulation |
| ___ 10. | Large implements used in the operation of a plant | bc. Skid |
| ___ 11. | A large flat structure that has several pieces of equipment mounted on it for easier moving if needed | bd. Pipe |

- | | | | |
|---------|---|-----|---------------------|
| ___ 12. | Located near the piping or equipment | a. | Vessel |
| ___ 13. | Located in a control room on a control board | b. | Instrument |
| ___ 14. | In the direction of the product flow | c. | Downstream |
| ___ 15. | In the direction opposite to the product flow | d. | Upstream |
| ___ 16. | A device used to control and/or indicate temperature, pressure, level, or flow in a pipe or equipment | e. | Pneumatic |
| ___ 17. | Moved or worked by air pressure | ab. | Car seal |
| ___ 18. | A device used to show that something has not been tampered with | ac. | Panel board mounted |
| ___ 19. | Container used in a piping system to hold, transform, or store a medium | ad. | Locally mounted |
| ___ 20. | Oil-free, moisture-free, compressed air system used to operate pneumatic control devices | ae. | Utility air |
| ___ 21. | Air line used in cleanup operations, to drive motors, and other service functions | bc. | Material balance |
| ___ 22. | Calculations completed by an engineer to show the end product, chemical position, impurity level, and all important aspects of a material being processed | bd. | Instrument air |

Match the types of flow diagrams on the right with the correct definitions on the left.

- | | | | |
|---------|---|----|------------|
| ___ 23. | Used by process engineers in designing what major equipment and lines are needed in a plant | a. | Utility |
| ___ 24. | Derived from process flow diagram and used in sizing pipe, system specifications, insulation, line numbers, and instrumentation controls | b. | Process |
| ___ 25. | Derived from mechanical flow diagrams and shows all other piping, system specifications, and minor equipment needed to make the plant run | c. | Mechanical |

Match the common flow diagram valves on the right with the correct functions on the left.

- | | | | |
|---------|--|-----|---------------------------------------|
| ___ 26. | Used to regulate pressure, flow direction, or operation sequence | a. | Check valve |
| ___ 27. | Used fully opened or completely closed for start/stop operations | b. | Gate valve |
| ___ 28. | Used to manually control pressure or flow rate in a line | c. | Pressure safety valve or relief valve |
| ___ 29. | Used in minimum space installations, has a 90° or 1/4 turn opened or closed position, and has limited throttling ability | d. | Globe valve |
| ___ 30. | Used mainly for opened or closed positions, but may be used for regulating flow; usually has a tight shut off position | e. | Control valve |
| ___ 31. | Used to stop the flow of liquid or gas in a line automatically in one direction only | ab. | Ball valve |
| ___ 32. | Used on a line to relieve pressure greater than the normal design pressure in that line. | ac. | Plug valve |
| 33. | Identify the following common flow diagram valve symbols. | | |



a. _____

b. _____



c. _____

d. _____

34. Identify the following common piping symbols.



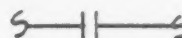
a. _____



b. _____



c. _____



d. _____



e. _____



f. _____

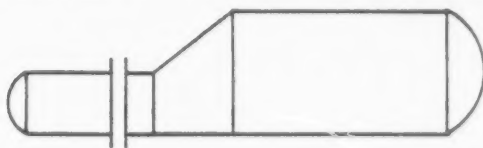


g. _____



h. _____

35. Identify the following common flow diagram equipment symbols.



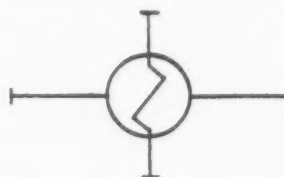
a. _____



b. _____



c. _____



d. _____

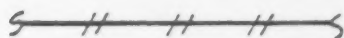
36. Identify the following common flow diagram instrumentation and electrical symbols.



a. _____ b. _____



c. _____ d. _____



e. _____ f. _____

37. Define the following instrumentation abbreviations.

a. LI _____
 b. TW _____
 c. PICV _____

38. Complete the following chart of abbreviations used on flow diagrams.

	FROM
	VALVE
PSIA	
NC	
	Furnished with equipment
D	
CF	
	Car seal open

Circle words or numbers in parentheses which best complete statements concerning how to draw flow diagrams.

39. Flow diagram sizes

- a. Process flow diagram is drawn on (12", 24"), 30", or 36" wide roll paper; length can be 5' to (6', 50')
- b. Mechanical and utility flow diagrams are drawn on (11" x 17", 22" x 34") or 24" x 36" size paper

40. Flow diagrams (are, are not) drawn to scale

41. Piping flow symbols

- a. Piping flow routing lines are drawn (thin, thick) dark
- b. Flanged valves are drawn 1/4" long and (1/4", 1/8") high with 30° angles; flanges are drawn Same height 3/32" from valve
- c. Screwed valves are drawn 1/4" long and 1/8" high with (30°, 45° angles)
- d. (Gate, Control) valves are drawn the same as screwed or flanged valves except for showing the actuator which is drawn 1/4" above pipe flow line with 3/16" half circle

42. Reducers

- a. Concentric reducers are drawn as if they were 1/2 of a (globe, gate) valve
- b. Eccentric reducers are drawn as if they were 1/2 of a (concentric reducer, globe valve)

43. Flow direction arrows are drawn as (large, standard) arrowheads

44. Insulation symbols

- a. These are drawn 7/32" high and (5/8", 3") long with a circle cylinder break
- b. Flange marks are drawn as a small (diamond, square)

45. Flow diagram transfer symbols are drawn 7/32" high and (1/4", 3/4") long

46. Line number break symbols are drawn with a 3/16" diameter curve and (do, do not) touch the flow line

47. Flange symbols are drawn 1/8" high with (3/32", 1/2") gap between flange marks

48. Weld caps are drawn 1/2 of a (3/16", 1") diameter circle

49. Blind flanges are drawn (1/2", 1/8") high next to a valve or flange

50. Line rating changes are usually placed by a valve or between (flanges, equipment) about 1/2" from the flow line

51. Instrument symbols
 - a. Instrument callouts are drawn in a $\frac{7}{16}$ " diameter (circle, ellipse)
 - b. The diagonal slash marks in pneumatic lines are drawn $\frac{1}{8}$ " high at a (90° , 45°) angle with no more than $\frac{1}{16}$ " distance between
52. Electrical lines are drawn as (thick, thin) hidden lines
53. Laying out a drawing
 - a. Lay out drawing with (light, heavy) construction lines
 - b. Allow ($\frac{1}{2}$ ", $3\frac{1}{2}$ ") from top border line for equipment titles
 - c. Allow (1 ", $3\frac{1}{2}$ ") above title block for main process flow lines and transfer symbols
54. Flow lines
 - a. Flow lines running (vertically, horizontally) have preference over (vertical, horizontal) lines
 - b. All flow lines are at least ($\frac{1}{4}$ ", 2 ") apart
55. Darkening in all lines is the (second, last) step in drawing a flow diagram.

Lesson 2

Match the terms on the right with the correct definitions on the left.

- | | | | |
|---------|--|-----|-------------------|
| ___ 56. | ANSI numbers assigned to pipe depending upon wall thickness | a. | Bonnet |
| ___ 57. | Approximate inside diameter of 1/8" to 12" steel pipe, and outside diameter of 14" and larger steel pipe | b. | Fitting |
| ___ 58. | Any type of pipe connector that is used to change size or direction, to make a connection, or to change the pipe specification from one point to another | c. | Nipple |
| ___ 59. | Standardized fittings and valves manufactured by various companies which are used to assemble a piping system | d. | Schedule numbers |
| ___ 60. | Any pipe shorter than 12" in length that can be threaded or welded | e. | Blind flange |
| ___ 61. | A metal fitting forged from low carbon steel that is welded to pipe for making a tee, cross, or side outlet | ab. | Alloy |
| ___ 62. | Solid plate-like fitting used to seal the end of a flanged end pipe line | ac. | Galvanized |
| ___ 63. | Double-flanged unit that has a blank that can be swiveled to either a closed or open position | ad. | Paddle flange |
| ___ 64. | A blind flange with a handle that is placed between two flanges | ae. | Components |
| ___ 65. | A metal that is composed of two or more metals | bc. | Spectacle flange |
| ___ 66. | Pipe that has been treated with molten zinc | bd. | Nominal pipe size |

List five types of metallic pipe materials and two types of nonmetallic pipe materials.

Metallic

- 67. _____
- 68. _____
- 69. _____
- 70. _____
- 71. _____

Nonmetallic

- 72. _____
- 73. _____

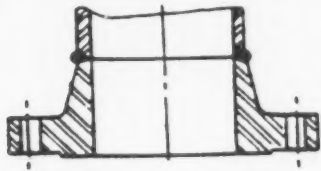
Circle words which best complete statements concerning pipe size and dimensions.

- 74. Pipe size is referred to by (actual, nominal) pipe ~~size~~.
- 75. Steel pipe 14" and (under, above) is designated by the actual OD and thickness of pipe walls.
- 76. Steel pipe (under, above) 14" is designated by the nominal diameter and schedule number.
- 77. Pipe is usually supplied at random lengths from (8, 16) to 22 feet.
- 78. Pipe may be supplied at double random length from 36 to (40, 60) feet.
- 79. Any round tubular products that are not in standardized pipe sizes are called (tubing, random).
- 80. The ID will vary with the (RFT, schedule) number on all pipe.

Match the types of pipe fittings on the right with the correct characteristics on the left.

- | | |
|--|------------------------|
| ___ 81. Easy to insulate, and form leak-proof connections, but are not easily dismantled | a. Butt weld |
| ___ 82. Used to make 45° and 90° branch pipe outlets, and eliminate the preliminary layouts of main branch lines | b. Threaded or screwed |
| ___ 83. Used for sanitary sewer lines | c. Flanged |
| ___ 84. Easily dismantled and assembled, but are more expensive to support from the existing structure because of higher weight load | d. Socket weld |
| ___ 85. Commonly used on low-temperature/low-pressure installations and on small pipes under 2 1/2" in diameter | e. Special bonnet weld |
| ___ 86. Do not require beveled pipe; provide a self-aligning joint | ab. Bell and spigot |

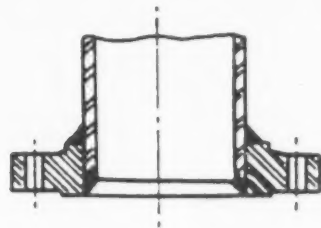
Identify the following types of flanges.



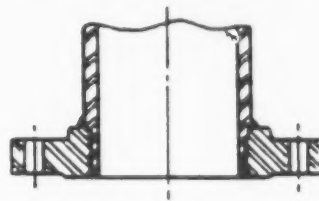
87. _____



88. _____

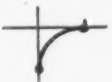
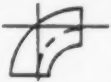
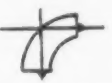
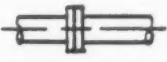
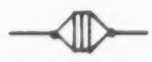


89. _____

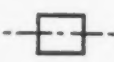
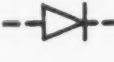


90. _____

Complete the following chart of welded fitting and flange symbols.

FITTINGS	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
91. _____		
Elbow, 90° short radius	92. _____	
93. _____		
Reducers, concentric and eccentric	 94. _____ CONC. ECC.	  CONC. ECC.
FLANGES	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
95. _____		
Slip-on	96. _____	
97. _____		
98. _____		

Complete the following chart of threaded fitting symbols.

THREADED FITTINGS	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
Elbow, 90°	99. _____	100. _____
Elbow, 45°		101. _____
102. _____		
103. _____		
Coupling, Full		
104. _____		
105. _____		

Provide the appropriate abbreviations or define the abbreviations given.

106. _____ Bell and Spigot

107. B/M _____

108. BW _____

109. _____ Concentric

110. _____ Coupling

111. ECC _____

112. FLG _____

- 113. _____ Field Weld
- 114. ID _____
- 115. MI _____
- 116. RED _____
- 117. _____ Raised Face
- 118. _____ Screwed
- 119. SO _____
- 120. SR _____
- 121. SS _____
- 122. _____ Weld Neck
- 123. _____ Weight

Circle words which best complete statements concerning drawing pipe and pipe components.

Drawing pipe

- 124. (Company standards, Textbook standards) determine whether pipe is to be drawn single line or double line.
- 125. Pipe break O.D.'s are drawn to scale for pipe that is (2", 6") or larger.

Drawing pipe components

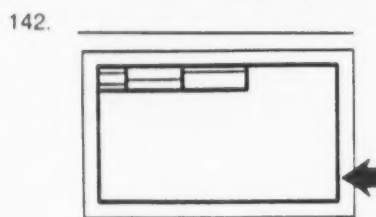
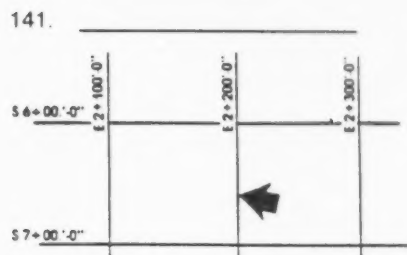
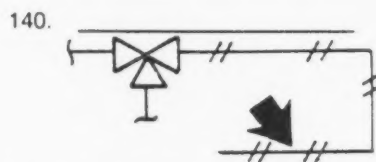
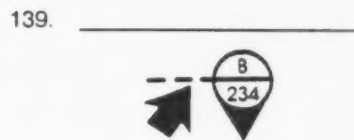
- 126. Long radius elbow's radius is (1 1/2, 2) times the nominal pipe size.
- 127. 45° elbow's radius is (1 1/2, 2) times the nominal pipe size.
- 128. All reducing fittings are drawn (single, double) line in single line piping.
- 129. Flange OD (is, is not) drawn to scale.
- 130. Orifice flanges are commonly drawn (5, 30) diameters upstream and (5, 30) diameters downstream of the flow in pipe from ells, tees, or branch connections.
- 131. Threads and socket welds (are, are not) drawn double line in double line drawings.

Lesson 3

Match the terms on the right with the correct definitions on the left.

- | | | |
|------------|--|-------------------------|
| 132. _____ | The field dealing with the drawing of pipe, pipe components, equipment, and structures and the layout of these items in a functional arrangement | a. Standard |
| 133. _____ | Any line drawing which illustrates the arrangement and relationship of the parts | b. Schematic |
| 134. _____ | The path of a product being made or refined shown on a schematic | c. Coordinate locations |
| 135. _____ | Devices used to control and/or indicate temperature, pressure, level, and flow in pipe or equipment in order to keep a system working efficiently and within required specifications | d. Pipe drafting |
| 136. _____ | Points on a plan drawing found using N/S or E/W dimensions from a reference point | e. Code |
| 137. _____ | Specification, test method, definition, classification, publication, or practice that has been approved by a committee to regulate or control manufacturing | ab. Instrumentation |
| 138. _____ | Systematic regulatory statements approved by a committee that are published for manufacturing control and use by the public | ac. Process flow |

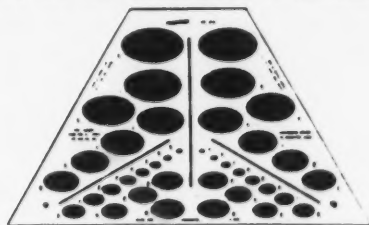
Identify the following types of lines.



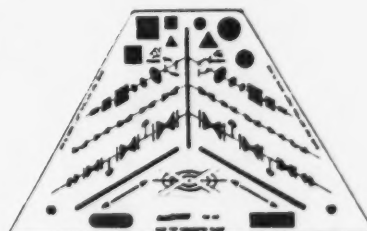
Match types of working drawings on the right with the correct definitions.

- | | | |
|------------|--|-----------------------------------|
| 143. _____ | Views of piping drawn to a scale of $\frac{3}{8}" = 1'-0"$ that show line sizes, flow direction, coordinate locations, basic horizontal overall dimensions, match lines, equipment identifications, line specification numbers, sectional-view references, or material call-outs | a. Isometrics |
| 144. _____ | Sectional views drawn to varying scales that show line sizes, vertical dimensions, coordinate locations, equipment identification, line specification numbers, and elevation dimensions | b. Plot plan and equipment layout |
| 145. _____ | Single or double line views not drawn to scale which show components, valves, fittings, dimensions, notes, and a bill of materials | c. Piping plans |
| 146. _____ | Views usually drawn to a scale of $\frac{1}{2}"$, $1"$, or $1 \frac{1}{2}" = 1'-0"$ which show details of special pipe fabrication, pipe supports, and structural piping | d. Elevations |
| 147. _____ | A single line schematic that is drawn with no scale and includes the process flow, major equipment, instrumentation, major valves, and line sizes, pressures, and temperatures | e. Mechanical flow diagram |
| 148. _____ | Drawing using information taken from site plan for the purpose of drawing to a scale of $1" = 20'-0"$ or $1" = 10'-0"$ the layout of buildings, equipment, and any physical information needed for design and construction of the piping system | ab. Special fabrication details |

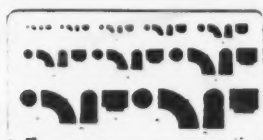
Identify the following types of templates.



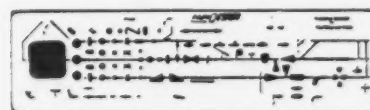
149. _____



150. _____



151. _____



152. _____

Match piping standards on the right with the correct purposes on the left.

- | | | |
|------------|--|----------|
| 153. _____ | Organization which provides services to industry including the standardization of different codes for piping, design, and dimensional properties | a. ASTM |
| 154. _____ | A non-profit national technical society which promotes engineering, standardizes different codes, and disseminates technical information of pertinent interest resulting in publication of these codes | b. PFI |
| 155. _____ | A non-profit national technical society which promotes the materials of engineering and standardizes specifications and the methods of testing | c. ANSI |
| 156. _____ | A non-profit national technical society which promotes water works piping or pipe fittings and standardizes specifications | d. AWWA |
| 157. _____ | A non-profit national technical society which promotes standardization in manufacturing of valves and fittings | e. API |
| 158. _____ | A non-profit national technical society which promotes the standardization of pipe fabrication, establishes limits of responsibility, and fixes tolerances | ab. ASME |
| 159. _____ | A non-profit national technical society which promotes standardization of specifications, materials, fabrication methods, testing, and uses in the petroleum industry | ac. MSS |

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Lesson 4

Match the terms on the right with the correct definitions on the left.

- | | | |
|-----------|--|----------------------------|
| 160. ____ | The study of the properties of triangles and trigonometric functions and their applications | a. X-ray |
| 161. ____ | A function of an arc or angle expressed as a ratio of pairs of sides of a right triangle | b. Trigonometry |
| 162. ____ | The side of a right triangle that is opposite the right angle | c. Tallying |
| 163. ____ | Reducing the stress in the metal with heat where a weld has been made | d. Hypotenuse |
| 164. ____ | A special photo taken to examine what the inside of a weld looks like | e. Field weld |
| 165. ____ | Putting water inside pipe under a certain pressure for a short time to find out if there are any flaws in the pipe | ab. Spool drawing |
| 166. ____ | The joining of two pieces of metal in a fabrication establishment | ac. Stress relieving |
| 167. ____ | The joining of two pieces of metal made on the site by the construction crew | ad. Mark number |
| 168. ____ | Support which helps carry some weight of the line, but which doesn't affect the process flow | ae. Hydrostatic testing |
| 169. ____ | Calculating the total number | bc. Trigonometric function |
| 170. ____ | A mark used to identify something in a numerical sequence | bd. Shop weld |
| 171. ____ | Drawing used in industry to call out and dimension a pipeline unit for fabrication | be. Dummy support |

Select true statements concerning isometric fitting representations by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- 172. ☐ There are two main planes in isometric drawing.
- 173. ☐ Each fitting has two main representations in each plane.
- 174. ☐ There can be an infinite number of supplementary planes.
- 175. ☐ Fittings are drawn to scale.
- 176. ☐ If a fitting is drawn on a drawing more than once, the size should not be changed.
- 177. ☐ Any special fitting that there isn't a symbol for, a new symbol will be made and noted in a legend.

Select true statements concerning special ballooning by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- 178. ☐ Special ballooning is used for all fittings on an isometric.
- 179. ☐ The number in the balloon will correspond to the line number on the piping plan.
- 180. ☐ If balloons are put on all fittings and valves, the drawing will be very cluttered.

Distinguish between characteristics of vents and drains by placing an "a" next to characteristics of vents. Mark a "b" next to characteristics of drains.

- 181. ☐ Put in all high points of a line
- 182. ☐ Put in all low points of a line
- 183. ☐ Used to let air out when filling up the line
- 184. ☐ Used to let water out of the line after testing

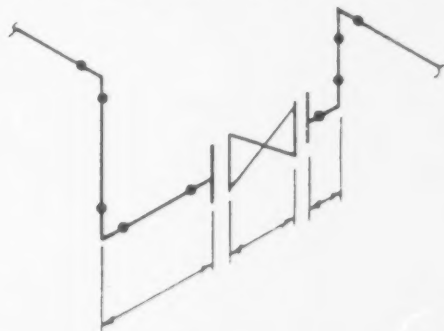
Select true statement concerning shop and field erection marks by placing an "a" in the appropriate blanks. Mark a "b" for false statements.

- 185. ☐ Shop and field erection marks are placed in circles on the isometric with leader lines.
- 186. ☐ The mark number has two numbers--the first number is the line number, the second is the piece number.
- 187. ☐ Each mark number is now called a field weld.
- 188. ☐ All pieces must fit on a truck float which is 100' x 40'.
- 189. ☐ No piece can be bigger than 3' wide, 40" long, and 4" high.
- 190. ☐ A closed weld dot is a shop weld.
- 191. ☐ An open weld dot is a spool.

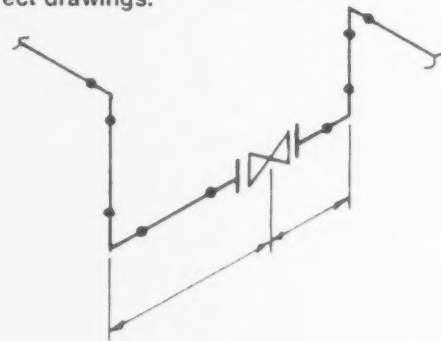
277

192. ____ In placing field welds on isometrics, try not to have any vertical welds.

Distinguish between correct and incorrect procedures for drawing isometrics by placing an "a" under each correct drawing. Place a "b" under incorrect drawings.



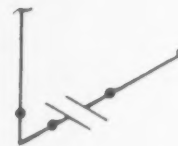
193.



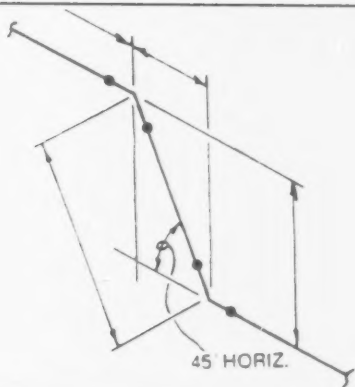
194.



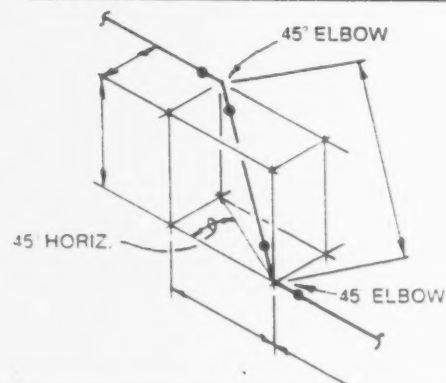
195.



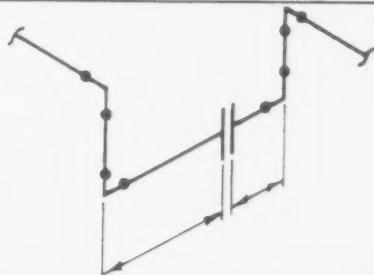
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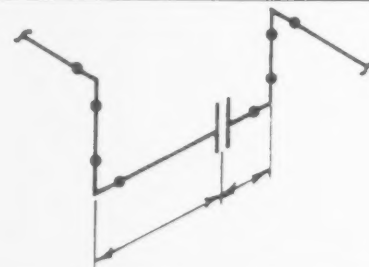
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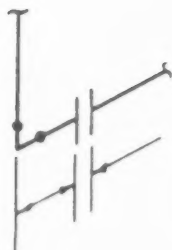
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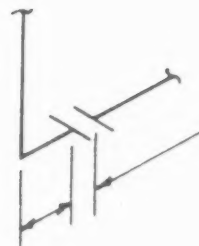
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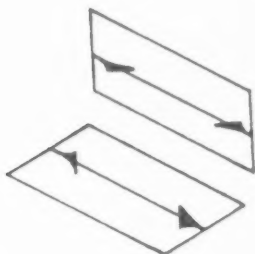
200.



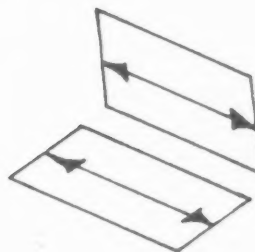
201.



202.



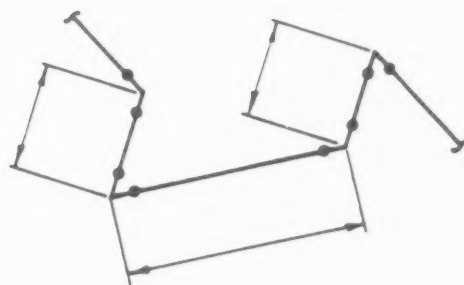
203.



204.



205.

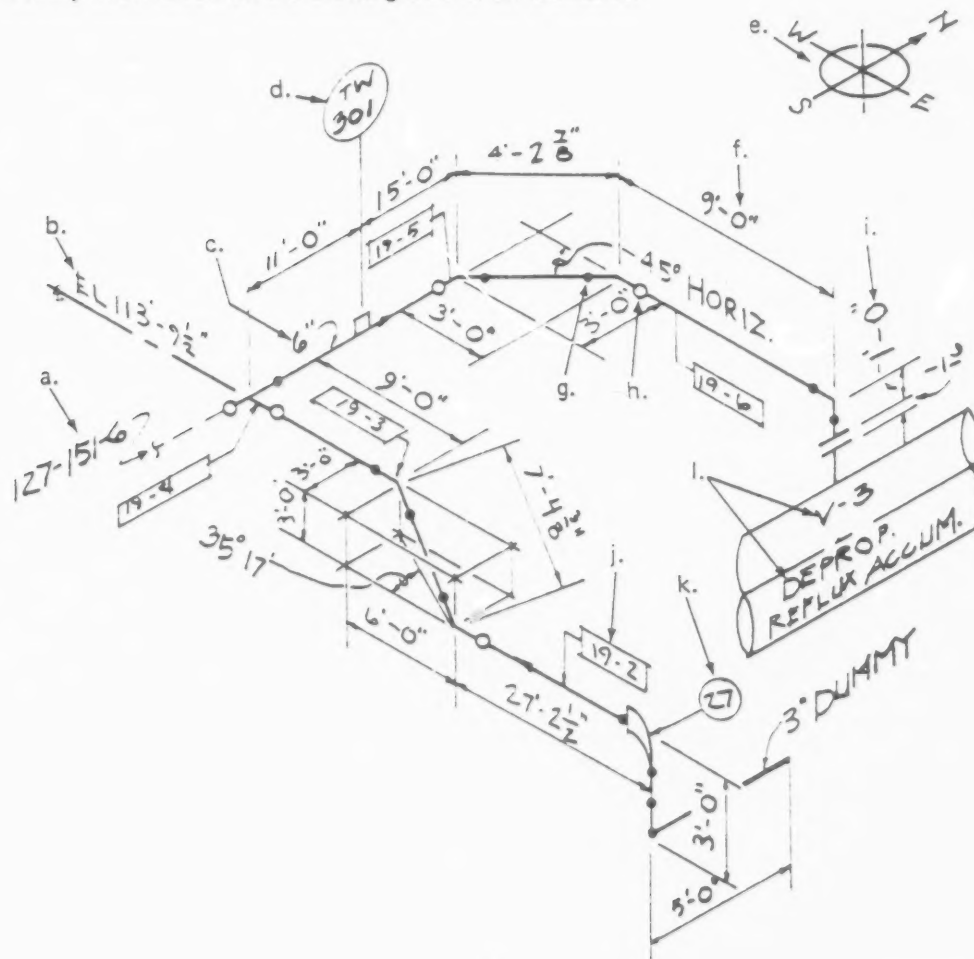


206.

207. List three purposes of isometrics.

- a. _____
- b. _____
- c. _____

208. Identify information on the drawing side of an isometric.



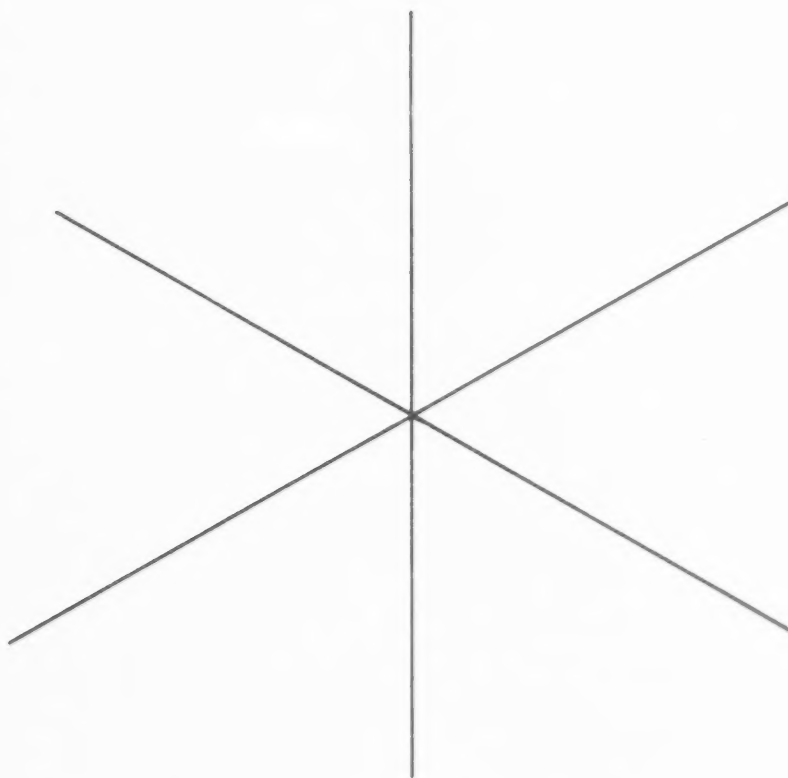
- | | |
|----------|----------|
| a. _____ | b. _____ |
| c. _____ | d. _____ |
| e. _____ | f. _____ |
| g. _____ | h. _____ |
| i. _____ | j. _____ |
| k. _____ | l. _____ |

209. Complete the following chart of single line isometric symbols.

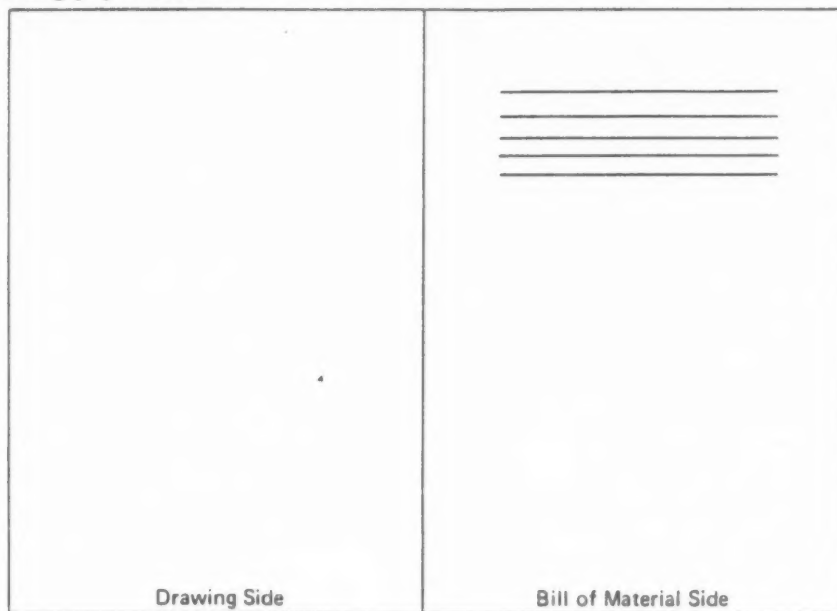
Fitting	Symbol	Fitting	Symbol
FLANGE, WN	a. _____	RED, ECC	b. _____
c. _____		SWAGE	
FLANGE, SW		UNION	d. _____
FLANGE, SCRD		ORIFICE, FLGD	
FLANGE, BLD	e. _____	f. _____	
g. _____		h. _____	
ELBOW, 45°		GLOBE VA	i. _____
ELBOW, 45° SW	j. _____	CHECK VA	
ELBOW, 45° SCRD		PLUG VA	k. _____
TEE, BUTT WELD I.	_____	CAP, WELDED	
m. _____		CPLG, THREADED n.	_____

Circle words in parentheses which best complete statements concerning drawing equipment on isometrics.

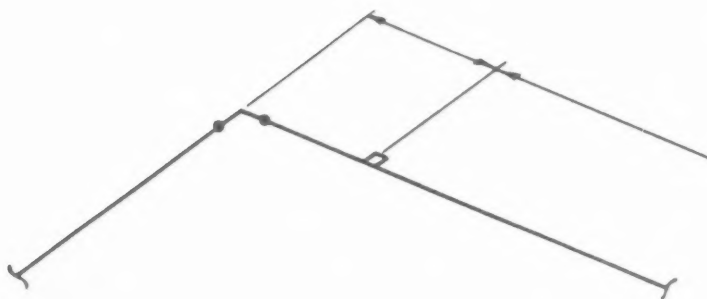
- 210. All manufactured equipment is shown on the isometric drawing as hidden lines or (thin, thick) lines
- 211. (All, Only a small part) of the manufactured equipment is shown
- 212. The item number and equipment title are shown (outside, inside) the hidden lines
- 213. Letter correctly in various planes by lettering in your first or last name in each plane below.



214. Draw and correctly place a north arrow using the preferred method on the imaginary sheet of drawing paper below.



215. Draw and letter an instrumentation balloon for a pressure indicator, number 242A, on the following line.



Circle words which best complete statements concerning connecting lines and numbers.

- 216. Connecting line numbers should be called out in full; this is to help in finding what (line, equipment) connects to it.
- 217. Where the line connects to another line, draw the weld dot (open, closed).
- 218. Connecting lines are drawn as (cutting plane lines, hidden lines).
- 219. Lines should only be broken on (pipe, valves).
- 220. Connecting lines (are, are not) dimensioned.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT V: INTRODUCTION TO PIPE DRAWINGS

ANSWERS TO UNIT TEST

Lesson 1 (M-1)

1. c
2. a
3. e
4. b
5. ac
6. bd
7. ab
8. ae
9. ad
10. d
11. bc
12. ad
13. ac
14. c
15. d
16. b
17. e
18. ab
19. a
20. bd
21. ae
22. bc
23. b
24. c
25. a
26. e
27. b
28. d
29. ac
30. ab
31. a
32. c

33.
 - a. Gate valve
 - b. Plug valve
 - c. Pressure safety valve or relief valve
 - d. Control valve
34.
 - a. Eccentric reducer
 - b. Concentric reducer
 - c. Flow diagram transfer symbol (balloon)
 - d. Flange connection
 - e. Blind flange
 - f. Flanged valve
 - g. Line number break
 - h. Weld cap
35.
 - a. Reboiler or chiller
 - b. Horizontal vessel
 - c. Mounted type pump
 - d. Heat exchanger
36.
 - a. Mounted behind the board instrument
 - b. Locally mounted instrument
 - c. Control room mounted or board mounted instrument
 - d. Field board mounted instrument
 - e. Instrument air or pneumatic signal flow line
 - f. Electrical signal line
37.
 - a. Level indicator
 - b. Temperature well
 - c. Pressure indicating control valve

38.

FR	FROM
VA	VALVE
PSIA	Pounds per square inch absolute
NC	Normally closed
*	Furnished with equipment
D	Drain
CF	Cubic feet
CSO	Car seal open

39. a. 24', 50'
b. 22" X 34"

40. Are not

41. a. Thin
b. 1/8"
c. 30°
d. Control

42. a. Gate
b. Concentric reducer

43. Standard

44. a. 5/8"
b. Diamond

45. 3/4"

46. Do not

47. 3/32"

48. 3/16"

49. 1/8"

50. Flanges

51. a. Circle
b. 45°

52. Thin

53. a. Light
b. 3 1/2"
c. 3 1/2"

54. a. Horizontally, vertical
b. 1/4"

55. Last

Lesson 2 (M-1)

- 56. d
- 57. bd
- 58. b
- 59. ae
- 60. c
- 61. a
- 62. e
- 63. bc
- 64. ad
- 65. ab
- 66. ac

67-71.

Metallic—any five of the following:

- a. Wrought iron and steel
- b. Galvanized
- c. Cast iron
- d. Brass-copper
- e. Lead
- f. Aluminum
- g. Stainless steel
- h. Alloys

- 74. Nominal
- 75. Above
- 76. Under
- 77. 16
- 78. 40
- 79. Tubing
- 80. Schedule
- 81. a
- 82. e
- 83. ab
- 84. c
- 85. b
- 86. d

87. Weld neck flange

88. Blind flange

89. Slip-on flange

90. Screwed flange

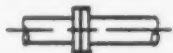
91-105. (See below and following page)

72-73.

Nonmetallic—any two of the following:

- a. Plastic
- b. Glass
- c. Clay
- d. Wood

FITTINGS	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
91. <u>Elbow, 90° long radius</u>		
Elbow, 90° short radius	92. 	
93. <u>Elbow, reducing, 90° long radius</u>		
Reducers, concentric and eccentric	  CONC. 94. ECC.	  CONC. ECC.

FLANGES	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
95. <u>Blind</u> _____		
<u>Slip-on</u> _____	96. 	
97. <u>Weld neck</u> _____		
98. <u>Orifice</u> _____		

THREADED FITTINGS	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
<u>Elbow, 90°</u> _____	99. 	100. 
<u>Elbow, 45°</u> _____		101. 
102. <u>Elbow, Street</u> _____		
103. <u>Cross</u> _____		
<u>Coupling, Full</u> _____		
104. <u>Reducer</u> _____		
105. <u>Swaged Nipple</u> _____		

- 106. B&S
- 107. Bill of material
- 108. Butt Weld
- 109. CONC
- 110. CPLG
- 111. Eccentric
- 112. Flange
- 113. FW
- 114. Inside Diameter
- 115. Malleable Iron
- 116. Reducer
- 117. RF
- 118. SCRD
- 119. Slip-On
- 120. Short Radius
- 121. Stainless Steel
- 122. WN
- 123. WT
- 124. Company standards
- 125. 2"
- 126. 1 1/2
- 127. 1 1/2
- 128. Double
- 129. Is
- 130. 30, 5
- 131. Are not

Lesson 3 (M-1)

- 132. d
- 133. b
- 134. ac
- 135. ab
- 136. c
- 137. a
- 138. e
- 139. Cutting plane line
- 140. Instrument air line
- 141. Coordinate lines
- 142. Border lines
- 143. c
- 144. d
- 145. a
- 146. ab
- 147. e
- 148. b
- 149. Isometric ellipse
- 150. Isometric piping
- 151. Pipe fitting
- 152. Flow
- 153. c
- 154. ab
- 155. a
- 156. d
- 157. ac
- 158. b
- 159. e

Lesson 4

160. b (M-1)
161. bc (M-1)
162. d (M-1)
163. ac (M-1)
164. a (M-1)
165. ae (M-1)
166. bd (M-1)
167. e (M-1)
168. be (M-1)
169. c (M-1)
170. ad (M-1)
171. ab (M-1)
172. b (M-2)
173. b (M-2)
174. a (M-2)
175. b (M-2)
176. a (M-2)
177. a (M-2)
178. b (M-2)
179. b (M-2)
180. a (M-2)
181. a (M-2)
182. b (M-2)
183. a (M-2)
184. b (M-2)
185. b (M-2)
186. a (M-2)
187. b (M-2)
188. b (M-2)
189. b (M-2)
190. a (M-2)
191. b (M-2)
192. b (M-2)
193. b (M-2)
194. a (M-2)
195. a (M-2)
196. b (M-2)
197. a (M-2)
198. b (M-2)
199. a (M-2)
200. b (M-2)
201. b (M-2)
202. a (M-2)
203. b (M-2)
204. a (M-2)
205. a (M-2)
206. b (M-2)
207. Any three of the following: (M-2)
 - a. For detailing and dimensioning of piping
 - b. For ordering final tally parts
 - c. For flagging special components
 - d. For supplying piping fabrication notes to fabricators
 - e. For shop fabrication
 - f. For piping installation by field crews
 - g. For a better understanding of all personnel
208. (M-2)
 - a. Connecting line number
 - b. Centerline elevation
 - c. Pipe size
 - d. Instrumentation balloon
 - e. North arrow
 - f. Centerline to centerline dimension
 - g. Shop weld
 - h. Field weld
 - i. Centerline to face dimension
 - j. Erection mark (spool mark)
 - k. Special fitting balloon
 - l. Equipment item number and title
209. (M-1) (see following page)
210. Thin (M-2)
211. Only a small part (M-2)
212. Inside (M-2)
- 213-215. (M-2) Evaluated to the satisfaction of the instructor
216. Line (M-2)
217. Open (M-2)
218. Hidden lines (M-2)
219. Pipe (M-2)
220. Are not (M-2)

Fitting	Symbol	Fitting	Symbol
FLANGE, WN		RED, ECC	
FLANGE, SO		SWAGE	
FLANGE, SW		UNION	
FLANGE, SCRD		ORIFICE, FLGD	
FLANGE, BLD		GATE VA	
ELBOW, 90°		BALL VA	
ELBOW, 45°		GLOBE VA	
ELBOW, 45° SW		CHECK VA	
ELBOW, 45° SCRD		PLUG VA	
TEE, BUTT WELD		CAP, WELDED	
TEE, RED		CPLG, THREADED	

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VI: INTRODUCTION TO STRUCTURAL STEEL DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to prepare detail drawings of structural steel members. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

- 6.1 Match terms related to structural drafting with the correct definitions.
- 6.2 Define structural drawing.
- 6.3 List three types of materials used for structures.
- 6.4 Match types of steel members with the correct characteristics and descriptions.
- 6.5 Identify structural steel shapes.
- 6.6 Select true statements about drawing practices for steel members.
- 6.7 Describe the placement of gage lines for steel members.
- 6.8 Complete statements concerning fastener sizes and spacings.
- 6.9 Complete statements concerning dimensioning procedures for steel structures.
- 6.10 Label a structural steel callout.
- 6.11 Select true statements concerning structural steel marking.
- 6.12 Demonstrate the ability to:
 - a) Prepare detail drawings of structural steel members. (AS 6.1)
 - b) Make a bill of materials. (AS 6.2)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VI: INTRODUCTION TO STRUCTURAL STEEL DRAWINGS

CONTENTS OF THIS UNIT

- A. Objective sheets
- B. References
- C. Notes to the instructor
- D. Lesson plan
 - 1. **Lesson 1: Structural Drafting** 375
 - a. Information outline
 - b. Transparency masters
 - TM 6.1: Structural Steel Shapes
 - TM 6.2: Gage Line Standards
 - TM 6.3: Dimensioning Procedures for Structural Steel
 - TM 6.4: Dimensioning Procedures for Structural Steel (continued)
 - TM 6.5: Dimensioning Procedures for Structural Steel (continued)
 - TM 6.6: Dimensioning Procedures for Structural Steel (continued)
 - TM 6.7: Dimensioning Beam Channels
 - c. Assignment sheets
 - AS 6.1: Prepare Detail Drawings of Structural Steel Members
 - AS 6.2: Make a Bill of Materials
 - d. Answers to assignment sheets
- E. Unit test
- F. Answers to unit test

REFERENCES

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- B. American Institute of Steel Construction, 400 North Michigan Avenue, Chicago, IL 60611.
 - 1. Manual of Steel Construction, USA, ©1980
 - 2. Structural Steel Detailing, ©1966
 - 3. Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings

- C. American Concrete Institute, P.O. Box 19150, Detroit, MI 48219.
 - 1. Detailing Manual. Publication SP-66, ●1980
 - 2. Building Code Requirements for Reinforced Concrete
 - 3. Recommended Practice and Standard Specifications for Concrete and Reinforced Concrete
- D. Bishop, Carlton. Structural Drafting. New York, NY: John Wiley & Sons, 2941.
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- L. Timber Construction Manual. American Institute of Timber Construction (AITC), 333 W. Hampton Avenue, Englewood, CO.
- M. Truss Plate Institute (TPI), 100 West Church Street, Frederick, MD 21701
- N. Typical Designs of Timber Structures. Timber Eng. Co., Washington, D.C.
- O. Weaver, Gerald. Structural Detailing. New York, NY: McGraw-Hill Book Co., 1974.
- P. Weaver, Rip. Structural Drafting. Houston, TX: Gulf Publishing Co., 1977.

NOTES TO THE INSTRUCTOR

- A. Suggested approaches to teaching this unit
 - 1. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

NOTE: This activity should be completed prior to the teaching of this unit.

- a. American Institute of Steel Construction (AISC)
7730 Carondelet Avenue
St. Louis, MO 63105
314/721-1332
 - b. American Concrete Institute (ACI)
P.O. Box 19150
Detroit, MI 48219
2. Integrate the following activities throughout the teaching of this unit:
- a. Visit a construction site and observe the various methods of construction for wood, steel, and concrete.
 - b. Review MAVCC books on architectural and light construction for standards on light frame construction.
 - c. Provide examples of actual structural details and engineering drawings used in structural drafting.
 - d. Take a field trip to a large civil engineering firm to see how the structural drafter fits in with civil drafting.
 - e. Provide copies of the AISC and ACI manuals for use in the assignment sheets.
 - f. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VI: INTRODUCTION TO STRUCTURAL STEEL DRAWINGS

LESSON 1: STRUCTURAL DRAFTING

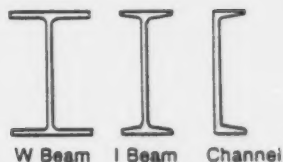
I. Terms and definitions

- A. **Bay**--the space between two consecutive sets or tiers of columns and beams, or columns and trusses
- B. **Bent**--a vertical framework, usually columns and beams supporting other members
- C. **Bottom chord**--the main member of a truss running along its lower side between supports and usually carrying tension and bending
- D. **Chord**--the top or bottom of a truss
- E. **Clear span**--the horizontal measurement between the inside faces of the two bearings or supports
- F. **Column**--a vertical compression member, usually supporting beams and girders
- G. **Compression**--a force caused by loads being on a member that causes a squeezing or shortening effect on the member
- H. **Concrete** (as defined by the American Concrete Institute (ACI))--a mixture of Portland cement, fine aggregate, coarse aggregate, and water
- I. **Cope**--to cut out a part of the top or bottom flange of a beam or channel so that it may fit another
- J. **Flange**--the top and bottom projection or outstanding parts of a beam, channel, or girder
- K. **Gage line**--the line along which fastener holes are punched or drilled in structural members
- L. **Girder**--a member designed to carry bending stress, usually supporting other members
- M. **Grout**--a fluid mixture of cement, water, and sand which can be poured to fill small voids or to smooth or level a surface of a wall or footing
- N. **Gusset plate**--a plate connecting the several members of a truss or other structural framework
- O. **Lintel**--a structural member designed to carry the wall over a window, door, or other opening
- P. **Nominal span**--horizontal distance between the outside edges of supports
- Q. **Panel**--the space between two purlins in a roof or between two vertical members in a bridge truss

- R. **Prestressed concrete**--concrete that is precast or cast in place that has wires or cables that are stretched before the concrete is placed around them; the releasing of the wires or cables sets up internal stresses that counteract the external stresses of the applied load to prevent cracking and sagging
- S. **Purlin**--the horizontal members spanning from truss to truss, upon which the roof is carried
- T. **Rafter**--the wood member used to support the roof in conventional framing
- U. **Rebar**--a round, square, or deformed bar used to reinforce concrete
- V. **Smooth bar**--a bar used in slip joints for expansion joints
- W. **Steel member**--a unit part of some larger structure
 Example: Floor beam or post in a steel bridge
- X. **Stress**--a unit of force working within a member expressed in pounds per square inch (PSI)
- Y. **Top chord**--main member of a truss running along its upper side supporting the decking and usually carrying combined compression and bending
- Z. **Truss**--a steel or timber framework whose members take only tension or compression stresses
- AA. **Web**--the portion of an I-beam, channel, or girder between the upper and lower flanges
- BB. **Working line**--the line where locating dimensions are given
- CC. **Working point (WP)**--the edge point where dimensions are given
- II. **Structural drawing**--all layout and detail drawings connected with the design and construction of buildings, bridges, viaducts, and similar structures in which structural steel, timber, concrete, and other building materials are used
- III. **Types of materials used for structures**
 - A. Steel
 - B. Concrete
 - C. Timber
- IV. **Types of steel members**
 - A. Beams
 - 1. Generally are composed of a single piece
 - 2. Generally are placed horizontally and are subjected to vertical loads
 - 3. Steel beams are standardized
 - a. Wide flange (W) beams

- b. "I" beams
- c. Channel (C)

Example:



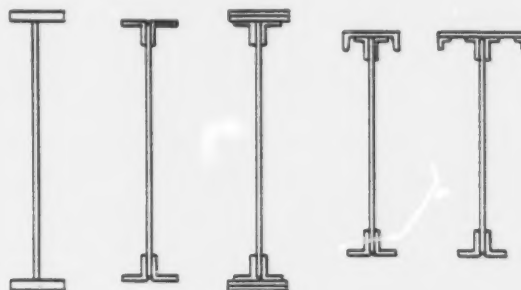
- 4. The length of a beam is the extreme dimension as shipped.

NOTE: When the connection angles are used at both ends, the length is the distance from back to back of angles.

B. Girders

- 1. Are beams made of more than one piece
- 2. Are members usually made with a web plate and flanges composed of angles, plates, or both, used to resist bending due to transverse loads

Examples:



- C. Columns--form the principal supports of all steel structures other than bridges and similar spans which rest directly upon masonry and concrete

D. Roof trusses

- 1. Roof trusses are used wherever a comparatively large area is to be covered without intermediate columns.
- 2. The web members of an ordinary roof truss are made of single or double angles with the longer legs vertical.
- 3. They are usually riveted or welded in the shop completely or in as large of sections as can be shipped.

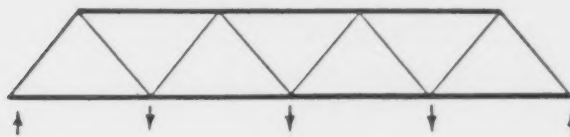
4. Different members of a truss are connected by means of a gusset plate.

E. Bridge trusses

1. Deck bridge--the floor load is applied along the upper chord



2. Through bridge--the floor load is applied along the lower chord, and traffic flows through the bridge trusses



3. The joints of a bridge truss may be riveted, welded, or pin connected.

V. Structural steel shapes (TM 6.1)

- A. American standard beam (S): I-beam--used for beams and struts
 - B. American standard channels (C)
 1. Used for struts and in trusses when light loads are required
 2. Used for steel platforming as load bearing members
 - C. Wide flange shapes (W)--used for beams and columns
 - D. Structural tees (WT and ST)--made by splitting S and W shapes
 - E. Angles (L)--used for struts, platforms, cross bracing in trusses, and to add framing strength
- NOTE: Legs of angles may be equal or unequal.**
- F. Flat bars (bar)--have a rectangular cross section and are standardly limited to 6" or 8" widths
 - G. Plate (PL or P_J)--rectangular cross section and is standardly limited to 6" or 8" widths
 - H. Floor plate (Floor PL or Floor P_J)--a skid resistant raised pattern on one side used for a walking surface

NOTE: A full listing of shape designations can be found in the AISC Manual of Steel Construction.

VI. Drawing practices for steel members

A. Typical drawing scale

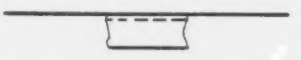
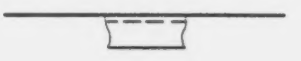
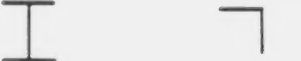
1. $3/8" = 1'0"$ --if overall dimensions can be shown on one drawing
2. $1/4" = 1'0"$ --used for large structures (framing and erection plans)
3. No scale--used for most detail drawings except:
 - a. $3" = 1'0"$ --details of joints
 - b. $1"$ or $1\ 1/2" = 1'0"$ --details of trusses

B. Drawing convention

NOTE: The drafter works from design layouts or framing plans prepared by architects or designers which show the arrangement of columns, girders, and beams. The detailer prepares a framing or erection layout which may show a plan view, elevation, or both identifying all members with a piece mark. Connections may be omitted and shown as assembly in trusses, columns, beams, and braces.

1. Single line drawing--used when the scale does not allow for a lot of detail.
 - a. Steel members are represented by a heavy line.
 - b. Along the heavy line a double line of the steel member will be placed to clarify angle or flange orientation.

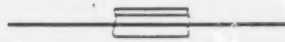
2. Single line in plan view represents

- | | |
|--------------------------------------|--|
| a. Centerline of beam |  |
| b. Back of channel |  |
| c. Work line of angle bracing |  |
| d. Back of angle when used as a beam |  |
| e. Centerline of structural tee |  |
| f. Column end view |  |

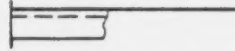
3. Single line in elevation view represents

- | | |
|----------------------------|--|
| a. Top of beam and channel |  |
|----------------------------|--|

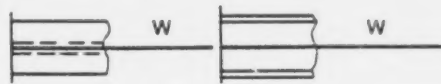
- b. Work line of angle or structural tee bracing



- c. Back of angle when used as beam or column

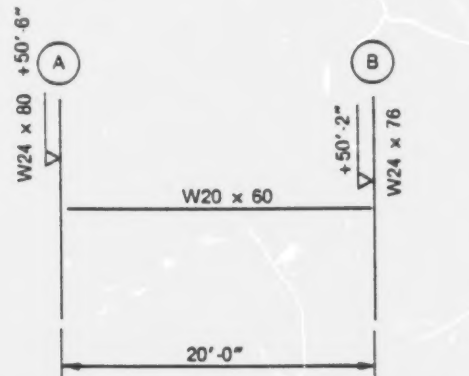


- d. Centerline of wide flange column



4. Design drawing

Example:



ELEVATION TOP OF STEEL SHOWN THUS (+50'-6")

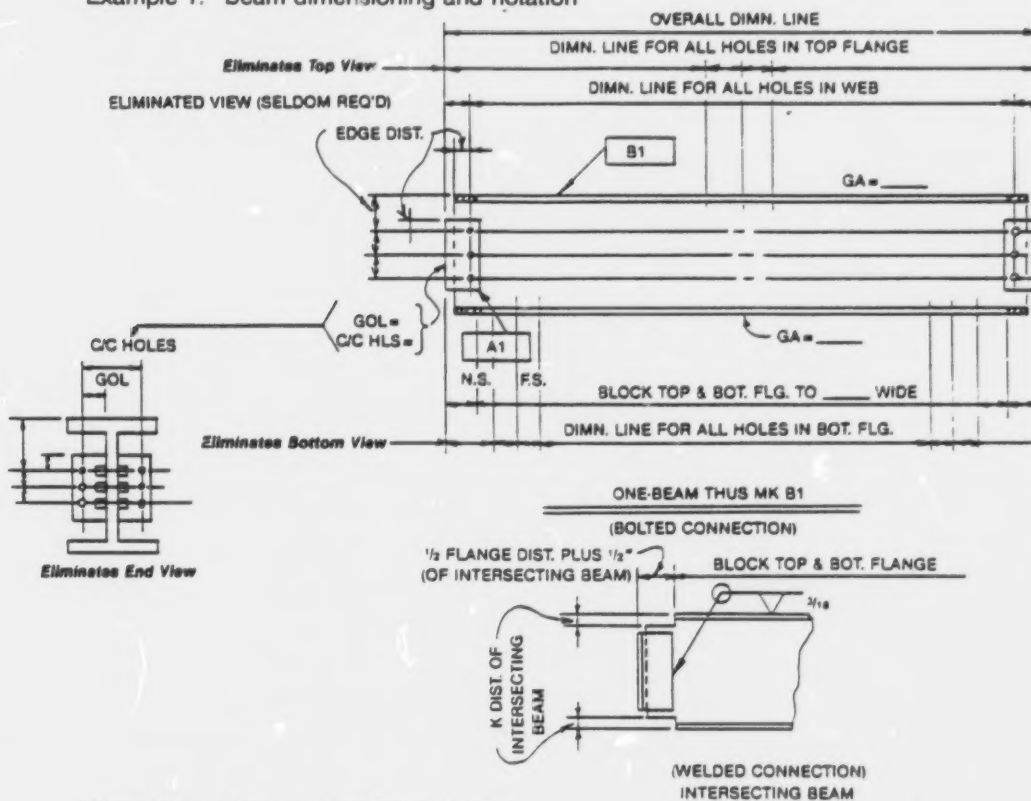
NOTES:

- ALL HOLES $\phi 1\frac{3}{16}$
- ALL CONNECTIONS TO DEVELOP FULL LENGTH UNLESS OTHERWISE SPECIFIED
- BOLTS: $\frac{3}{4}$ A325
- CONNECTING ANGLES WELDED TO BEAM, BOLTED TO SUPPORT

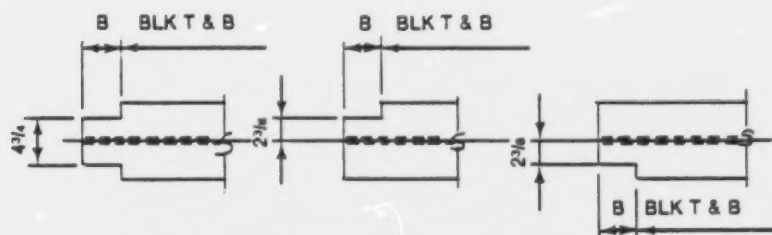
- a. Gives the structural detailer information to set up complete detail drawings
 - 1) Length
 - 2) Size and type
 - 3) Number and types of fasteners
- b. Describes the type of construction and end loads
- c. Members on design drawings are presumed to be parallel or at right angles to one another.
- d. Elevation view dimensions of beams are generally given as notes on drawings prepared by the designer/architect.

5. Because of industry concern about improving productivity of detailers, a method of special dimensioning practices and notation has been devised to eliminate otherwise necessary views. Examine the following examples describing these techniques.

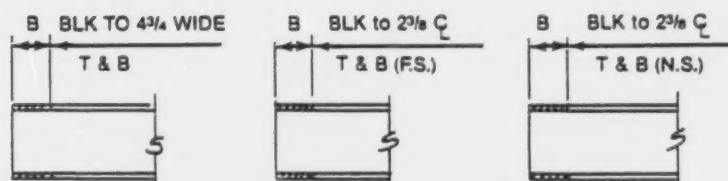
Example 1: Beam dimensioning and notation



Example 2: Blocking (coping) of beams



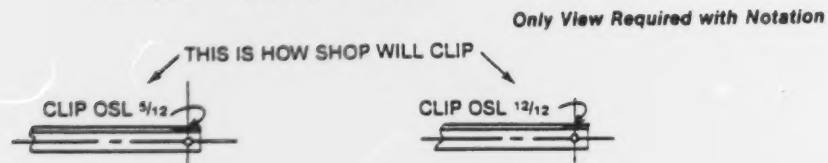
WHEN FLANGE VIEW IS SHOWN



WHEN WEB VIEW IS SHOWN

Example 3:

Example 3: Clipping of angles



CLIP AND BACKSUT ANGLES ONLY WHEN REQUIRED USING 5 TO 12 OR 12 TO 12 BEVELS.
HOLD OTHER BEVELS TO A MINIMUM.

6. Symmetrical members

- a. Large members such as trusses and plate girders are symmetrical about a centerline and only one half is detailed.
- b. It is standard to detail the left half.
- c. The detail should be broken past the centerline by a ragged or wavy line.

7. Standard details

- a. Many steel details have become standardized and the drafter should become familiar with and adhere to these. Standards specifications can be found in the AISC Steel Construction Manual.
- b. Many firms have printed forms showing required views of a beam and it is only necessary for the drafter to fill in the dimensions.

VII. Placement of gage lines (TM 6.2)--the lines along which fastener holes should be placed in the flanges of I-beams, channels, and angles are standardized.

- A. Angles--gage line is measured from the back of the angle
- B. Flanges of channels--gage line is measured from the back of the channel
- C. Flanges of I-beams--gage line is measured from the center
- D. Standard gages for I-beams, channels, and angles are located in the AISC Steel Construction Manual.

VIII. Fastener sizes and spacings

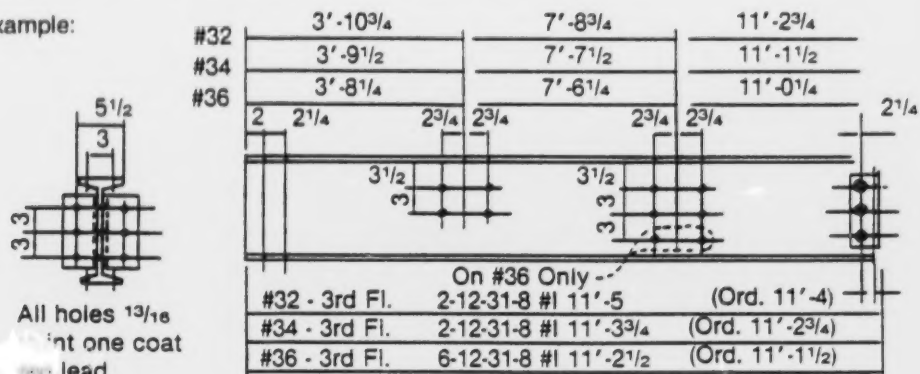
- A. Minimum distance for fastener spacing along the gage line has been established by the AISC.
- B. The minimum fastener size is governed by the following rule: The diameter of the fastener should never be less than the thickness of the metal punched.

IX. Dimensioning procedures for steel structures (TMs 6.3-6.7)

- A. Use aligned method for locating dimensions.
- B. Dimensions are in feet and inches and should be placed on top of the dimension line.
- C. Longest and overall dimension should be farthest away from the view.
- D. The detail dimensions should always be added to see if they check with the overall dimension.
- E. Dimensions should be placed no closer than 5/16" apart and the first line should be no closer than double this distance.
- F. Dimensions should be given to centerline of beams and backs of angles and channels.
- G. Dimensions should be given to the top or bottom of beams and channels, never to both top and bottom.
- H. Where a dimension line runs through a hole whose location it does not give, the dimension line should be broken and an arc drawn around the hole.
- I. If a particular dimension is for attachment of a column, beam, or equipment to be mounted on the structure, a notation "HOLD" should be indicated next to the dimension.
- J. When four or more equal spaces between bolts are required, a note is used such as 4 @ 2 = 8.
- K. Elevation detail dimensions known as levels are usually given as notes on the drawing.
 - 1. A reference point is established in the structure, usually top of concrete floor or foundation.
 - 2. Elevations above this point are plus values.
 - 3. Elevations below this point are minus values.

- L. When beams are of the same size and vary only in length, the same drawing can be used for several beams. A set of dimensions for each beam are shown.

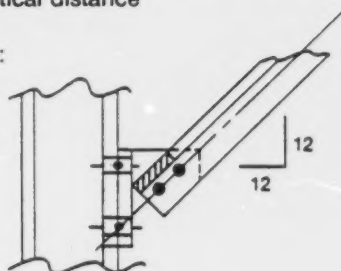
Example:



- M. The slope of all members should be given in rise and run, not angles.

1. Run--horizontal distance
2. Rise--vertical distance

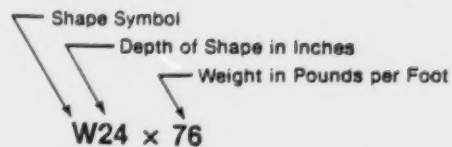
Example:



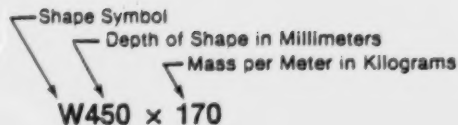
- N. End distances and edge distances are usually given by note on light truss members and dimensioned on beams, columns, and girders.
- O. Gage lines should be dimensioned even though they are standard.
- P. When lengths of fasteners vary, the various lengths and quantities should be shown at connections on the erection plan or in a reference list.
- Q. On truss members, detail dimensions should be placed in a continuous row from end to end of the member with no dimension being omitted.

X. Structural steel callouts

A. Inch designation



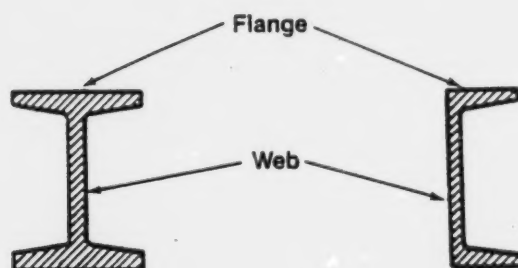
B. Metric designation



XI. Structural steel marking

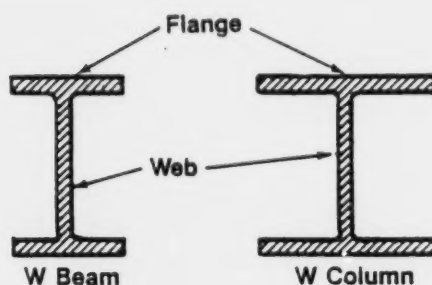
- A. Marks are used to provide a systematic procedure for detailing, fabricating, and erection.
- B. Each member of a structure is given a mark on the design layout.
- C. Mark is painted on the piece and used to erect the structure in the field.
- D. Each company has its own system of marking.
- E. For more information on marking systems, refer to AISC Structural Steel Detailing.

STRUCTURAL STEEL SHAPES



American Standard
Beam

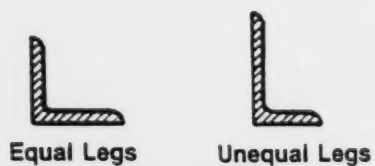
American Standard
Channel



W Beam

W Column

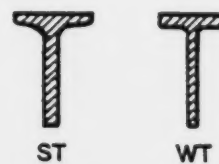
Wide Flange Shapes



Equal Legs

Unequal Legs

Angle Shapes (L)



ST

WT

Structural Tees

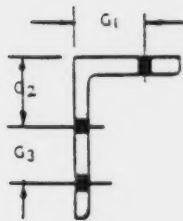


Plate (PL)



Flat Bar (Bar)

GAGE LINE STANDARDS



GAGE	LEG SIZE (Inches)										
	8	6	5	4	3 1/2	3	2 1/2	2	1 3/4	1 1/2	1
G1	4 1/2	3 1/2	3 1/8	2 1/2	2 3/8	1 3/4	1 3/8	1 3/16	1	7/8	5/8
G2	3 1/8	2 3/8	1 3/4								
G3	3 1/8	2 1/2	2								

FLANGE WIDTH	G
2 3/8 to 2 3/4	1 1/2
3 to 3 3/8	1 3/4
3 1/2 to 4	2
4 to 4 3/4	2 1/8
5 to 5 3/4	3
6 to 7 1/4	3 3/4
7 1/2 to 8	5

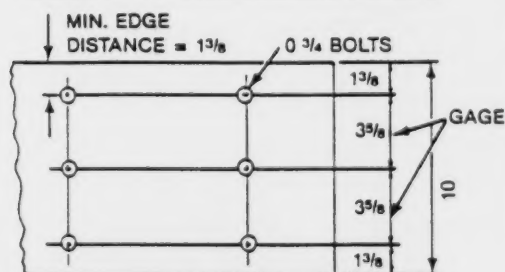
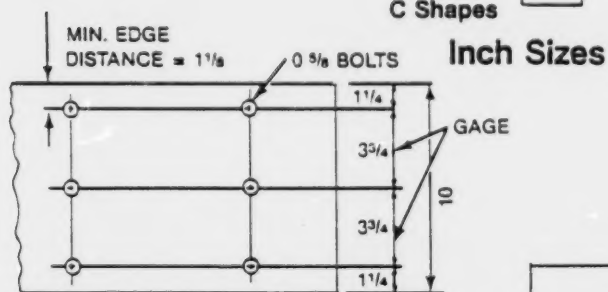
S Shapes

FLANGE WIDTH	G
1 3/8 to 1 1/2	3/4
1 3/4	1
1 3/4 to 2	1 3/16
2 1/8	1 3/16
2 1/8 to 2 3/8	1 3/8
2 1/2 to 2 3/4	1 1/2
2 7/8 to 3 1/8	1 3/4
3 3/8 to 3 5/8	2 1/8
3 3/4 to 4 3/8	2 1/2

C Shapes

FLANGE WIDTH	G
4	2 1/8
5 to 5 3/4	3
6 to 7 1/8	3 3/4
7 1/2 and Up	5 1/8

DEPTH OF W AND M COLUMN	G	
	2 1/8	2 1/2
6	3 3/4	3
8	5	3 1/2
10 to 14		

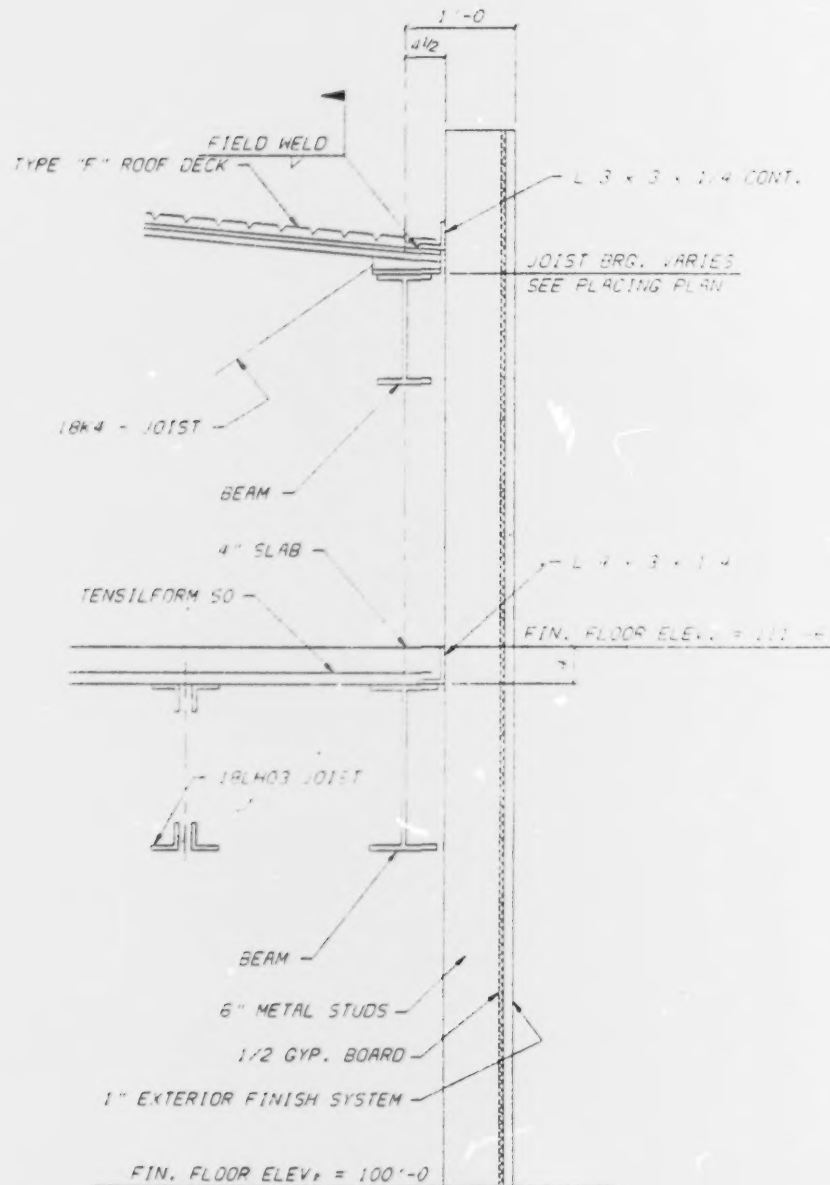


**Establishing Gage Sizes
from Edge Distance**

	Bolt Diameter	At Sheared Edge	At Rolled or Gas Cut Edge
U.S. Customary (Inches)	1/2	1	3/4
	5/8	1 1/8	7/8
	3/4	1 3/8	1
	7/8	1 1/2	1 1/8
	1	1 5/8	1 3/16
	1 1/8	1 3/4	1 3/8
	1 1/4	2	1 1/2
	1 3/8	2 1/2	1 13/16

**Minimum Edge
Distance for Bolt**

DIMENSIONING PROCEDURES FOR STRUCTURAL STEEL (continued)

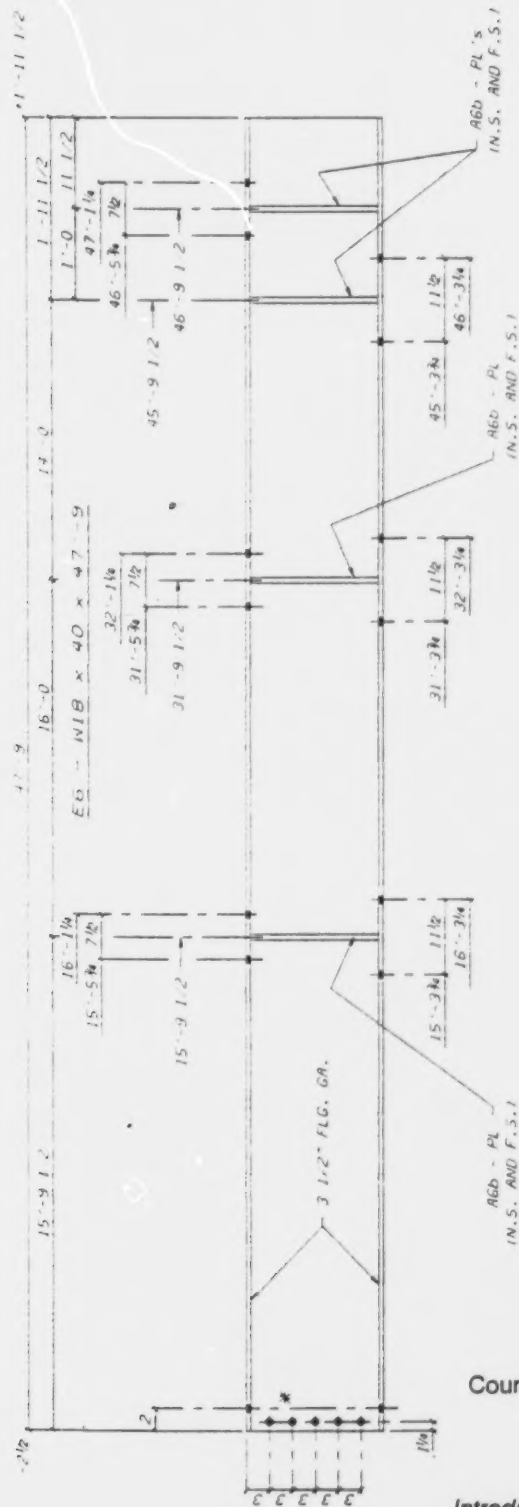


SECTION

A
3

Courtesy of DeLong's, Inc., Jefferson City, MO

Introduction to Structural Steel Drawings 393

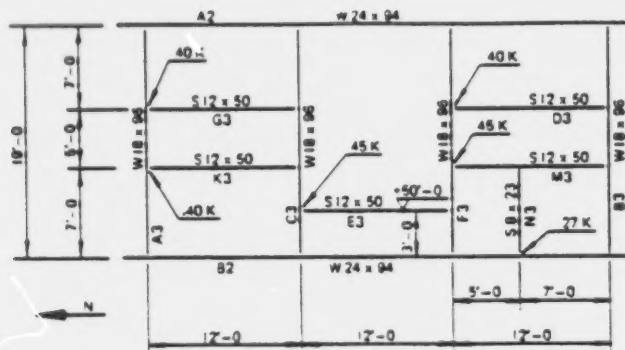


MAKE - ONE - E6

Introduction to Structural Steel Drawings 399

PREPARE DETAIL DRAWINGS OF STRUCTURAL STEEL MEMBERS

Given: Floor plan



ELEVATION: TOP OF STEEL TO BE (+50'-3") UNLESS OTHERWISE SHOWN
NOTES: ALL HOLES Ø 8" BOLTS Ø 7/8"-A325

Directions: Use the AISC Manual of Steel Construction for reference.

1. Set up the final drawing "B" or "C" size vellum.
2. Use scale $3/8" = 1'0"$.
3. Prepare complete detail drawings of beams D3, E3, M3, N3, and C3, using framed beam connections. Refer to the transparencies as needed.
 - a. Dimension to centerline of channel webs.
 - b. Connection angles are welded to the beams. (Use 3/16 fillet weld.)
 - c. Outstanding angles are bolted to the connecting beams.
4. Make drawing of beam connections. Scale $1" = 1'0"$

MAKE A BILL OF MATERIALS

Directions: Make a bill of materials for one of the drawings in AS 6.1 or use a drawing assigned by the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT VI: INTRODUCTION TO STRUCTURAL STEEL DRAWINGS
ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VI: INTRODUCTION TO STRUCTURAL STEEL DRAWINGS

UNIT TEST

Match the terms on the right with the correct definitions on the left.

- | | | | |
|---------|---|-----|--------------|
| ___ 1. | A force caused by loads being placed on a member that causes a squeezing or shortening effect on the member | a. | Bay |
| ___ 2. | A vertical compression member, usually supporting beams and girders | b. | Bent |
| ___ 3. | The top and bottom projection or outstanding parts of a beam, channel, or girder | c. | Bottom chord |
| ___ 4. | The top or bottom members of a truss | d. | Chord |
| ___ 5. | The space between two consecutive sets or tiers of columns and beams, or columns and trusses | e. | Clear span |
| ___ 6. | A fluid mixture of cement, water, and sand which can be poured to fill small voids or to smooth or level a surface of a wall or footing | ab. | Column |
| ___ 7. | The main member of a truss running along its lower side between supports and usually carrying tension and bending | ac. | Compression |
| ___ 8. | To cut out a part of the top or bottom flange of a beam or channel so that it may fit another | ad. | Concrete |
| ___ 9. | A vertical framework, usually columns and beams supporting other members | ae. | Cope |
| ___ 10. | The line along which fastener holes are punched or drilled in structural members | bc. | Flange |
| ___ 11. | A mixture of Portland cement, fine aggregate, coarse aggregate, and water | bd. | Gaze line |
| ___ 12. | A member designed to carry bending stress, usually supporting other members | be. | Girder |
| ___ 13. | That horizontal measurement between the inside faces of the two bearings or supports | cd. | Grout |

- | | | | |
|---------|---|-----|----------------------|
| ___ 14. | The horizontal members spanning from truss to truss, upon which the roof is carried | a. | Gusset plate |
| ___ 15. | A unit of force working within a member expressed in pounds per square inch | b. | Lintel |
| ___ 16. | A structural member designed to carry the wall over a window, door, or other opening | c. | Nominal span |
| ___ 17. | Horizontal distance between the outside edges of supports | d. | Panel |
| ___ 18. | A bar used in slip joints for expansion joints | e. | Prestressed concrete |
| ___ 19. | A steel or timber framework whose members take only tension or compression stresses | ab. | Purlin |
| ___ 20. | The line where locating dimensions are given | ac. | Rafter |
| ___ 21. | A unit part of some larger structure | ad. | Rebar |
| ___ 22. | The space between two purlins in a roof or between two vertical members in a bridge truss | ae. | Smooth bar |
| ___ 23. | A round, square, or deformed bar used to reinforce concrete | bc. | Steel member |
| ___ 24. | The wood members used to support the roof in conventional framing | bd. | Stress |
| ___ 25. | A plate connecting the several members of a truss or other structural framework | be. | Top chord |
| ___ 26. | Main member of a truss running along its upper side supporting the decking and usually carrying combined compression and bending | cd. | Truss |
| ___ 27. | Concrete that is precast or cast in place that has wires or cables that are stretched before the concrete is placed around them; the releasing of the wires or cables sets up internal stresses that counteract the external stresses of the applied load to prevent cracking and sagging | ce. | Web |
| ___ 28. | The portion of an I-beam, channel, or girder between the upper and lower flanges | de. | Working line |

29. Define structural drawing.

List three types of material used for structures.

30.

31.

32.

Match types of steel members on the right with the correct characteristics or descriptions.

NOTE: Members on the right may be used more than once.

- 33. Form the principal supports of all steel structures other than bridges and similar spans which rest directly upon masonry and concrete
- 34. Are used wherever a comparatively large area is to be covered without intermediate columns
- 35. Generally are composed of a single piece
- 36. Are beams made of more than one piece
- 37. Are usually made with a web plate and flanges composed of angles, plates, or both, used to resist bending due to transverse loads
- 38. For the through type, the floor load is applied along the lower chord, and traffic flows through it
- 39. Generally are placed horizontally and are subjected to vertical loads
- 40. The web members are made of single or double angles with the longer legs vertical
- 41. On the deck type, the floor load is applied along the upper chord

- a. Beams
- b. Girders
- c. Columns
- d. Roof trusses
- e. Bridge trusses

Identify the following structural steel shapes.



42. _____

43. _____



44. _____

45. _____



46. _____

47. _____

48. _____

Select true statements by writing an "a" in the blank if it is true and a "b" in the blank if it is false.

- ___ 49. A scale of 1" = 1'-0" is typically used for drawing a large structures (framing and erection plans.)
- ___ 50. No scale is used for most detail drawings (except on joints and trusses).
- ___ 51. Double line drawings are used when the scale doesn't allow for a lot of detail.
- ___ 52. The design prepared by the designer/architect gives the structural detailer information to set up complete detail drawings.
- ___ 53. Large members such as trusses and plate girders are symmetrical about a centerline and only one half is detailed.

Describe the placement of gage lines for the following steel members.

54. Angles-- _____
55. Flange of a channel-- _____
56. Flange of an I-beam-- _____

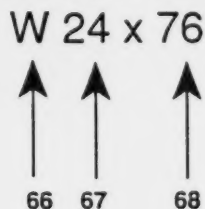
Complete the following statements concerning fastener sizes and spacings by circling the correct words.

57. The minimum distance for fastener spacing along the gage line has been established by the (AISC, ACI).
58. The minimum fastener size is governed by the following rule: The diameter of the fastener should never be (less, more) than the thickness of the metal punched.

Complete the following statements concerning dimensioning procedures for steel structures by circling the correct words.

59. Use (unidirectional, aligned) method for locating dimensions.
60. Dimensions are in feet and inches and should be placed (in the middle, on top) of the dimension line.
61. Longest and overall dimension should be (closest to, farthest away from) the view.
62. Dimensions should be placed no closer than (5/16", 1/2") apart and the first line should be no closer than double this distance.
63. Dimensions should be given to (centerline, backs) of beams.
64. Dimensions should be given to the top (or, and) bottom of beams and channels.
65. The slope of all members should be given in (rise and run, angles).

Label the following structural steel callout.



66. _____
67. _____
68. _____

Select true statements concerning structural steel marking procedures by placing an "a" next to the true statements and a "b" next to the false statements.

- 69. ___ Marks are used to provide a systematic procedure for detailing, fabricating, and erection.
- 70. ___ Each member of a structure is given a mark on the design layout.
- 71. ___ Mark is painted in the piece and used to erect the structure in the field.
- 72. ___ Every company uses the same system of marking.

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VI: INTRODUCTION TO STRUCTURAL STEEL DRAWINGS

ANSWERS TO UNIT TEST

1. ac (N-1)
2. ab (N-1)
3. bc (N-1)
4. d (N-1)
5. a (N-1)
6. cd (N-1)
7. c (N-1)
8. ae (N-1)
9. b (N-1)
10. bd (N-1)
11. ad (N-1)
12. be (N-1)
13. e (N-1)
14. ab (N-1)
15. bd (N-1)
16. b (N-1)
17. c (N-1)
18. ae (N-1)
19. cd (N-1)
20. de (N-1)
21. bc (N-1)
22. d (N-1)
23. ad (N-1)
24. ac (N-1)
25. a (N-1)
26. be (N-1)
27. e (N-1)
28. ce (N-1)
29. (N-1) Structural drawing--all layout and detail drawings connected with the design and construction of buildings, bridges, viaducts, and similar structures in which structural steel, timber, concrete, and other building materials are used.
30. Steel (N-1)
31. Concrete (N-1)
32. Timber (N-1)
33. c (N-1)
34. d (N-1)
35. a (N-1)
36. b (N-1)
37. b (N-1)
38. e (N-1)
39. a (N-1)
40. d (N-1)
41. e (N-1)
42. Structural tees (N-1)
43. Angles (N-1)
44. Flat bar (N-1)
45. Plate (N-1)
46. Wide flange shape (N-1)
47. Channel (N-1)
48. Beam (N-1)
49. b (N-2)
50. a (N-2)
51. b (N-2)
52. a (N-2)
53. a (N-2)
54. Angles--gage line is measured from the back of the angle. (N-2)
55. Flanges of a channel--gage line is measured from the back of the channel. (N-2)
56. Flanges of an I-beam--gage line is measured from the center. (N-2)
57. AISC (N-2)
58. Less (N-2)
59. Aligned (N-2)
60. On top (N-2)
61. Farthest away from (N-2)
62. 5/16" (N-2)
63. Centerline (N-2)
64. Or (N-2)
65. Rise and run (N-2)
66. Shape (N-3)
67. Depth (N-3)
68. Weight (N-3)
69. a (N-3)
70. a (N-3)
71. a (N-3)
72. b (N-3)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify symbols used in drafting and state abbreviations for words commonly used in civil drafting. In addition, the student should be able to interpolate contours from a grid survey, prepare profiles from the contour map, and calculate grades in percent. Also, the student should be able to plan a preliminary subdivision map, complete a final plat map, and lay out a plat from a legal description and field notes. Competencies will be demonstrated by correctly completing the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

Lesson 1: Standard Symbols and Abbreviations

- 7.1 Match terms related to standard symbols and abbreviations with the correct definitions.
- 7.2 List common types of symbols used in civil drafting.
- 7.3 State abbreviations for words commonly used in civil drafting.
- 7.4 Select true statements concerning factors that determine when an abbreviation should be used.
- 7.5 State two purposes of symbols on maps.
- 7.6 Identify U.S.G.S. topographic map symbols.
- 7.7 Identify other conventional topographic symbols.
- 7.8 Identify boundary, fence, and track fixture symbols.
- 7.9 Match civil symbols with the correct meanings.
- 7.10 Identify utility and service symbols.
- 7.11 Match hydrographic and navigation symbols with the correct meanings.
- 7.12 Draw examples of north arrow symbols.
- 7.13 Select true statements concerning general rules for drawing map symbols.
- 7.14 List methods used in drawing symbols.
- 7.15 Match color codes with corresponding map symbols.
- 7.16 Identify common material symbols used in structural and architectural drawings.

7.17 Demonstrate the ability to:

- a) Set up a map legend. (AS 7.1)
- b) Locate and identify symbols and features on a U.S.G.S. map. (AS 7.2)

Lesson 2: Topographic Mapping

- 7.18 Match terms related to topographic maps with the correct definitions.
- 7.19 List uses of topographic maps.
- 7.20 Match types of surveys used in topographic mapping with the size of area to be mapped.
- 7.21 Arrange in order the steps in laying out a topographic survey.
- 7.22 Match the methods used to establish contours with the correct descriptions.
- 7.23 Select true statements concerning the selection of contour intervals.
- 7.24 Complete statements concerning characteristics of contour lines.
- 7.25 Match contour line features with their correct configurations.
- 7.26 Arrange in order the steps used to develop a profile from a contour map.
- 7.27 Demonstrate the ability to interpolate contours from a grid survey and prepare profiles from the contour map. (AS 7.3)

Lesson 3: Plats

- 7.28 Match terms related to plats with the correct definitions.
- 7.29 Complete statements concerning legal descriptions.
- 7.30 List guidelines for drafting a plat.
- 7.31 List methods for laying out and developing a map.
- 7.32 Demonstrate the ability to:
 - a) Lay out a boundary survey from a legal description. (AS 7.4)
 - b) Reduce field notes and plot a simple boundary survey. (AS 7.5)

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT-VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS

CONTENTS OF THIS UNIT

- A. Objective sheet
 - B. References
 - C. Notes to the instructor
 - D. Lesson plans
- 1. **Lesson 1: Standard Symbols and Abbreviations** 421
 - a. Information outline
 - b. Assignment sheets
 - AS 7.1: Set up a Map Legend
 - AS 7.2: Locate and Identify Symbols and Features on a U.S.G.S.
 - c. Answers to assignment sheets
 - 2. **Lesson 2: Topographic Mapping** 449
 - a. Information outline
 - b. Transparency masters
 - TM 7.1: Random Shot Method for Establishing Contours
 - TM 7.2: Grid Method for Establishing Contours
 - TM 7.3: Cross Profile Method for Establishing Contours
 - c. Assignment sheet
 - AS 7.1: Interpolate Contours From a Grid Survey and Prepare Profiles From the Contour Map
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 - 3. **Lesson 3: Plats** 469
 - a. Information outline
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 - TM 7.4: Example of a Legal Description
 - TM 7.5: Types of Land Descriptions Used in a Legal Description

- c. Assignment sheets
 - AS 7.4: Lay Out a Boundary Survey From a Legal Description
 - AS 7.5: Reduce Field Notes and Plot a Simple Boundary Survey
- d. Answers to assignment sheets
- E. Unit test
- F. Answers to unit test

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NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Lesson 1: Standard Symbols and Abbreviations

- a. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this lesson.

NOTE: This activity should be completed prior to the teaching of this lesson.

- b. Use a topographic map of your local area to locate specific symbols used on the map.
- c. Have students find the abbreviations or symbols for the terms and definitions of each lesson. This can be used as an assignment sheet.
- d. Using vendor catalogs, look up the templates that can be used in civil drafting. List vendor, template name, number, and scale.
- e. Daily, list a symbol or abbreviation on the chalkboard and have a mini quiz or contest on determining the correct feature or label these stand for.
- f. Refer to ANSI standards Y 14.5 to review with students the standard line conventions for drafting.
- g. Meet individually with students to evaluate their progress through this lesson, and indicate to them possible areas for improvement.

2. Lesson 2: Topographic Mapping

- a. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this lesson.

NOTE: This activity should be completed prior to the teaching of this lesson.

- b. Obtain aerial photos for the U.S.G.S. quad map of your local area.
- c. Call or write to the NCIC Headquarters/U.S.G.S. for information on how to order topographic maps for your area.

NCIC Headquarters
National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, VA 22092
703/860-6045

- d. Take a field trip and identify contour configurations on the ground.
- e. Choose an area around the school and prepare an isometric sketch of the terrain.

- f. Show examples of aerial photographs, orthophotographs, and stereo models.
- g. Demonstrate the use of a stereoscope, and have students practice viewing aerial photos.
- h. Meet individually with students to evaluate their progress through this lesson, and indicate to them possible areas for improvement.

3. **Lesson 3: Plats**

- a. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this lesson.
- b. Set up a visit to your local planning office and look at the plat books.
- c. Obtain a copy of your local subdivision drafting standards from your planning office or city engineer.
- d. Invite your city engineer to speak to your class.
- e. Obtain the legal description for the property your school is on and draft a plat showing the boundary and exact location of the school.
- f. Meet individually with students to evaluate their progress through this lesson, and indicate to them possible areas for improvement.

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MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS

LESSON 1: STANDARD SYMBOLS AND ABBREVIATIONS

I. Terms and definitions

- A. **Boundary**—a line of demarcation between adjoining parcels of land
- B. **Cultural features**—man-made features such as railroads, bridges, roads, and public utilities
- C. **Geological**—the structure and composition of the earth's crust
- D. **Hydrographic features**—features along the shore and the submerged parts of bodies of water
- E. **Legend**—a description, explanation, table of symbols, and other information which are printed on a map or chart for better understanding and interpretation

NOTE: The legend includes only those symbols that need an explanation. If a symbol is labeled on the map, it does not need to be included in the legend.

- F. **Map scale**—the relationship existing between a distance on a map and the corresponding distance on the earth
- G. **Natural land features**—features on a map such as lakes, streams, terrain, and vegetation
- H. **Navigation**—method of charting waters which affords a channel for useful commerce or travel
- I. **Planimetry**—showing the details of a map in plan view (generally culture and water features)
- J. **Symbol**—a diagram, design, letter, or abbreviation which by convention or reference to a legend is understood to represent a specific characteristic or object

II. Types of symbols commonly used in civil drafting

- A. Map symbols
- B. Drawing symbols (ANSI standards for types of lines)
- C. Labels in the form of abbreviations
- D. Pipe symbols
- E. Weldment symbols (types of welds)
- F. Utility symbols
- G. Material symbols
- H. Oil and gas symbols

III. Abbreviations of commonly used words in civil drafting

NOTE: These are used on maps and drawings as labels.

A

Abandoned
Abbreviations
Above
Abutment
Access
Acre
Acre-foot
Addition
Adjusting, adjacent
Afternoon
Aggregate
Alternate, altitude
Aluminum
American Concrete Institute
American Institute of Steel
Construction
American National Standards
Institute
Anchor
Anchor bolt
Angle
Approach
Approved
Approximate
Apron
Area
Area drain
Article
Asbestos
Asbestos cement, asphaltic concrete
Asphalt
Assembly
Assistant
Associate
Association
Automatic
Auxiliary
Avenue
Average
Avoirduois
Azimuth

ABD
ABBR
ABV
ABUT
ACC
AC
AC-Ft
ADD.
ADJ
PM
AGG
ALT
AL
ACI
AISC
ANSI
AHR
AB
Angle
APPR
APPO
APPROX
APR
A
AD
ART
ASB
AC
ASPH
ASM
ASST
ASSOC
ASSN
AUTO
AUX
AVE
AVG
AVDP
AZ

B

Background
Backsight
Back to back
Barbed wire
Barrel
Baseline
Basement
Bearing
Bearing value
Begin
Beginning of project
Bell and spigot
Below

BKGD
BS (*)
B to B
BW
BBL
BL or B
BSMT
BRG
BV
BEG
BOP
B & S
BLW

Bench mark/Beam
Between
Beveled
Bituminous
Bituminous coated corrugated metal
pipe culvert
Bituminous coated and paved
corrugated metal pipe culvert
Bituminous coated pipe arch culvert
Bituminous coated and paved pipe
arch culvert
Black/block
Board
Board feet
Bolt
Bottom
Boulders
Boulevard
Boundary
Bridge
Brook
Brown
Building
Built-up
Bulkhead
Bureau of Public Roads
Bushe
Butterfly valve

BM
BETW
BEV
BIT
BCCMP
BCPCMP
BCPA
BCPPA
BLK
BD
FBM
BLT
BOT
B
BLVD
BNDY/BDY
BR
Brook
BRN
BLDG
B/U
BLKHD
BPR
BU
BV

C

Capacity
Capital
Cast iron
Cast iron pipe
Cast iron soil pipe
Catch basin
Ceiling
Cement, Cemetery
Centerline
Center
Centers
Center to center
Centimeter(s)
Chain
Change
Channel
Checked
Church
Circular
Clay
Clear, clearance
Cleanout
Coated
Coefficient
Column
Computations
Concrete
Concrete cylinder pipe

CAP
CAP
CI
CIP
CISP
CB
CLG
CEM
CL
CTR
CTRS
C to C
CM
CH
CHG
Channel
CKD
CH
CIR
CL
CLR
CO
CTD
COEF
COL
COMP
CONC
CCP

Concrete masonry units
Concrete pipe
Connection
Construction
Construction joint
Continuation
Continuous
Continued
Contract
Contract limit line
Contractor
Contraction
Control
Control of access
Coordinate
Corner
Corrugated iron
Corrugated metal
Corrugated metal pipe
Corrugated metal pipe arch culvert
County
County road
Creek
Cross road
Cross section
Cubic
Cubic foot
Cubic feet per minute
Cubic feet per second
Cubic yard
Culvert
Curb and gutter
Curve to spiral
Cylinder

D

Degree
Degree of curvature
Delta
Demolish, demolition
Department
Depressed
Designed
Diagonal
Diameter
Dimension
Directional
Distance
Down
Drawn
Drawing
Drawings
Drop inlet

E

Each
Each face
Each way
East
Elbow
Electrical
Electronic distance meter
Elevation (above sea level)

CMU
CP
CX, CONN
CONST
CJ
CONT
CONT
CONTO
CONT
CCL
CONTR
CONTR
CONTR
CofA
COORD
COR
CORR I
CM
CMP
CMPA
CO
CO RD
CR
X RD
X SECT
CU
CF
CFM
CFS
CY
CULV
C&G
CS
CYL

DEG
D
Delta
DEM
DEPT
DEP
DSGN
DIAG
D or DIAM
DIM
DIR
DIST
DN
D or DR
DWG
DWGS
DI

EA
EF
EW
E
ELL
ELEC
EDM
EL

Elevation (view)
Emergency
Enclosure
End of project
End to end
End vertical curve
Engineer
Engineering
Equal
Equally spaced
Equation
Equipment
Equivalent
Estimate
Excavation
Existing
Expansion
Expansion joint
Extension, Exterior, External
External distance
Extra

F

Face of concrete
Face to face
Federal
Federal Aid
Federal Aid Interstate
Federal Aid Primary, Federal Aid Project
Federal Aid Secondary
Feet
Feet board measure
Feet per minute
Feet per second
Ferry
Figure
Finish grade
Fire hydrant
Flange, flanged
Flexible
Floor, floor line, flow
Floor cleanout
Floor drain
Flow line
Flush hole
Foot
Footing
Ford
Forenoon
Foresight
Foundation
Frontage road
Full size
Future

G

Gage
Gallon
Gallons per minute
Gallons per second
Galvanized iron
Gate valve

ELEV
EMERG
ENCL
EOP
E to E
EVC
ENGR
ENGG
EQ
EQL SP
EQ
EOPT
EQUIV
EST
EXC
EXST
EXP
EXP JT
EXT
E
Extra

FOC
F to F
FED
FA
FAI
FAP
FAS
FT
FBM
FPM
FPS
FY
FIG
FG
FH
FLG
FLEX
FL
FCO
FD
FLL
FH
FT
FTG
FD
AM
FS
FON
FNTG RD
FS
FUT

GA
GAL
GPM
GPS
GI
GTV

General	GENL	M	
Granite	GRN	Maximum	MAX
Gravel	GVL	Mean sea level	MSL
Green	GRN	Median	MED
Grid north	GN	Membrane	MMB
Ground	GRD/GND	Meridian	MER
		Mile	MI
H		Miles per hour	MPH
Handrail	HR	Millimeter(s)	MM
Header	HDR	Minimum, Minute	MIN
Height	HGT	Miscellaneous	MISC
Height of instrument	HI		
Hexagonal	HEX	N	
High water	HW	National	NATL
Highway	HWY	National Geodetic Survey	NGS
Horizontal	HORIZ	Negative	NEG
Horsepower	HP	Nominal	NOM
Hose bib	HB	North	N
Hour	HR	Northeast	NE
House	HSE or H	Northwest	NW
Hub drain	HD	Not applicable	NA
		Not to scale	NTS
I		Number	NO
Inch	IN	Numbers	NOS
Including	INCL	O	
Incorporated	INC	Obscure	OBS
Information	INF	On center	OC
Influent	INFL	Opening	OPNG
Inside diameter	ID	Opposite	OPP
Inside face	IF	Orange	ORN
Installation	INSTL	Original	ORIG
Interlock	ILK	Ounce	OZ
Intermediate	INTER/INTM	Outside diameter	OD
Interstate highway	IH	Outside face	OF
Iron pipe, iron pin	IP	Outside to outside	O to O
Invert	INVT	Overall	QA
Invert elevation	IE		
J		P	
Joint	JT	Page	P
Junction	JNCT/JCT/JT	Pages	PP
Junction box	JB	Paragraph, Parallel	PAR
		Parking	PK
L		Piling	PLG
Lake	Lake	Piping	PP
Lateral	LATL	Plan and profile sheet	P&P SHEET
Latitude	LAT	Pave(d)(ing)	PV
Left	LT	Pavement	PVMT,PAVT
Length	LGTH	Plane	PL
Length of curve	L	Plate, property line	PL
Length of tangent	T	Point	PT
Light	LT	Point of beginning	POB
Lighting	LTG	Point of compound curvature	PCC
Limestone	LMS	Point of curvature	PC
Linear	LIN	Point of intersection	PI
Linear foot	LIN FT	Point of reverse curve	PRC
Longitude, Longitudinal	LONG	Point of tangency	PT
Low point	LPT	Point on curve	POC
Low water	LW	Point on tangent	POT
Manhole	MH	Polyvinyl chloride	PVC
Material	MTL	Portland cement concrete	PCC

Pound
Pounds per square inch gauge
Power
Power pole
Precast
Pressure
Pressure reducing valve
Primary
Principal meridian
Project

Q

Quadrangle
Quart

R

Radius
Railroad
Railway
Rain drain, roof drain
Range
Receved
Reduction
Reference
Reference point
Reflector
Regular
Reinforced
Reinforced concrete
Reinforced concrete pipe
Reinforcement, reinforcing
Remove
Replace
Required
Reverse
Revision
Right
Right lane
Right-of-way
River
Road
Roadway
Round
Route

S

Sanitary sewer
Schedule
Second
Secondary
Section
Section line
Separate
Service
Sheet
Shore(d)(ing)
Signal
South
Southeast
Southwest
Special

LB
PSIG
PWR
PP
PRCST
PRES
PRV
PRI
PRIN MER
PROJ

QUAD
QT

R or RAD

RR
RY
RD
R
RECD
REDUC
REF
RP
REFL
REG
REINF
RC
RCP
REINF
RMVREM
REPL
REQD
RVS
REV
RT
RT LN
R/W, ROW
R
RD
RDY
RD
RTE

SAN S
SCH, SCHED
SEC
SECD
SECT
SL or S
SEP
SERV
SH
SHO
SIG
S
SE
SW
SPL

Specification(s)
Spillway
Spiral to curve
Spiral to tangent
Square
Square foot
Square inch
Square mile
Square yard
Standard
State
State Aid Project
State highway
State work order
Station
Steel
Storm sewer
Straight, Stream
Street
Structure, Structural
Submerged
Substructure
Superstructure
Support
Survey
Symmetrical
System

T

Tangent
Telegraph
Telephone
Telephone pole
Temperature, temporary
Temporary benchmark
Terminal
Terra cotta
Thick
Thickness
Thousand
Tolerance
Tongue and groove
Top and bottom
Top face
Top of
Top of concrete
Top of steel
Top of wall
Topography
Township
Transom
Transverse
True north
Turning point
Typical

SPEC
SPLWY
SC
ST
SQ
SQ FT
SQ IN
SQ MILE
SQ YD
STD
State
SAP
SH
SWO
STA
STL
SS
STR
ST
STR
SUBMG
SUBSTR
SUPERSTR
SUP
SURV
SYM
SYS

TAN/T
TELG
TELP
TP
TEMP
TBM
TERM
TC
THK
THKNS
M
TOL
T&G
T&B
TF
TO
TC
TST
TW
TOPO
TWP/T
TR
TRANSV
TN
TP
TYP

U

Undercut
Underground
Upstream
U.S. Geological Survey
U.S. Coast & Geodetic Survey

UC
UG
UPSTR
USGS
USC & GS

V

Variable
Vertical
Vertical curve
Vertical grain
Volume

VAR
VERT
VC
VG
VOL

W

Water surface, waterstop, welded
steel
Water tank, Weight
West
White
With
Without
Working point

WS
WT
W
WHT
W/
W/O
WP

Y

Yard
Year
Yellow

YD
YR
YEL

IV. Factors that determine the usage of an abbreviation

- Use an abbreviation when necessary to save time and space.
- Use an abbreviation only when the meaning is unquestionably clear to the intended reader.
- Be sure to use a standard abbreviation, not your own shortened version.

NOTE: When in doubt, spell it out.

V. Purposes of symbols on maps

- To represent the location and identity of land features that are generally too large to be shown in detail on the map
- To help keep information on a map to a minimum and thereby avoid cluttering

NOTE: The purpose of the map dictates the types of symbols used.

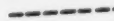
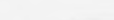
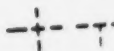
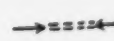
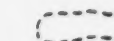
VI. U.S.G.S. topographic map symbols

NOTE: Variations will be found on older maps.

Primary highway, hard surface		Road under construction, alignment known	
Secondary highway, hard surface		Proposed road	
Light-duty road, hard or improved surface		Dual highway, dividing strip 25 feet or less	
Unimproved road			

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Dual highway, dividing strip exceeding 25 feet		Wells other than water (labeled as to type)		Oil, ... Gas
Trail		Tanks: oil, water, etc. (labeled only if water)		Water
Railroad: single track and multiple track		Located or landmark object; windmill		!
Railroads in juxtaposition		Open pit, mine, or quarry; prospect		x x
Narrow gage: single track and multiple track		Shaft and tunnel entrance		Y Y
Railroad in street and cartline		Horizontal and vertical control station:		
Bridge: road and railroad		Tablet, spirit level elevation		BM Δ 5653
Drawbridge: road and railroad		Other recoverable mark, spirit level elevation		Δ 5455
Footbridge		Horizontal control station: tablet, vertical angle elevation		VABM Δ 95/9
Tunnel: road and railroad		Any recoverable mark, vertical angle or checked elevation		Δ 3775
Overpass and underpass		Vertical control station: tablet, spirit level elevation		BM X 957
Small masonry or concrete dam		Other recoverable mark, spirit level elevation		X 954
Dam with lock		Spot elevation		x 7369 x 7369
Dam with road		Boundaries: National		
Canal with lock		State		
Buildings (dwelling, place of employment, etc.)		County, parish, municipal		
School, church, and cemetery		Civil township, precinct, town, barrio		
Buildings (barn, warehouse, etc.)		Incorporated city, village, town, hamlet		
Power transmission line with located metal tower				
Telephone line, pipeline, etc. (labeled as to type)				

Reservation, National or State		Mine dump	
Small park, cemetery, airport, etc.		Wash	
Land grant		Tailings	
Township or range line, United States land survey		Tailings pond	
Township or range line, approximate location		Shifting sand or dunes	
Section line, United States land survey		Intricate surface	
Section line, approximate location		Sand area	
Township line, not United States land survey		Gravel beach	
Section line, not United States land survey			
Found corner: section and closing		Perennial streams	
Boundary monument: land grant and other		Intermittent streams	
Fence or field line		Elevated aqueduct	
Index contour		Aqueduct tunnel	
Intermediate contour		Water well and spring	
Supplementary contour		Glacier	
Depression contours		Small rapids	
Fill		Small falls	
Cut		Large rapids	
Levee		Large falls	
Levee with road		Intermittent lake	
		Dry lake bed	

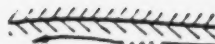
Foreshore flat		Rock, bare or awash; dangerous to navigation	
Rock or coral reef		Marsh (swamp)	
Sounding, depth curve		Submerged marsh	
Piling or dolphin		Wooded marsh	
Exposed wreck		Mangrove	
Sunken wreck			

VII. Other conventional topographic symbols

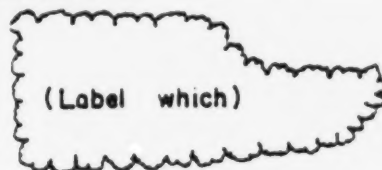
City line		Store	
Fence line		House	
Right-of-way line		Barn	
Limited access line		School	
Shore line		Existing side drain pipe	
Marsh		Proposed fence (limited access)	
Hedge		Inlet (drainage map)	
Trees		Manhole	
Edge of wooded area		High water elevation	H. W. EL.
Shrubbery		Direction of flow	
Bridges over 20' span		Block and lot lines	
Curb and gutter (proposed) dash exist- ing curb and gutter			
Curb (proposed) dash existing curb			
Gate			
Church			
		Creeks and rivers	

BEST COPY AVAILABLE

Terraces (ticks pointing down grade)



Timber, orchard, brush or nursery



R/W line and marker in place



R/W line and marker new



Point of intersection (PI)



Principal points along survey $\mathcal{L}$



Horizontal control station



VIII. Boundary, fence, and track fixture symbols

A. Details of railways, boundary and survey lines

Steam



Foreign Track (Show rd. initials) (color other than red or black)



Electric



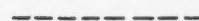
Foreign R. of W. Line



Street Rwy



Center line



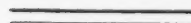
Narrow gauge



Company R of W (property line)



Present track to remain



Fence on street



Present track to be removed



Fence on Rwy property line



Proposed track (Red)



Proposed future track (Red)



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B. Fences

Board fence or fence in
general



Stone fence



Picket fence



Rail fence



Barbed wire fence



Smooth wire fence



Hedge fence



Worm fence



C. Details of track fixtures and accessories

Turnout and switch stand



Spring switch



Detail (block)



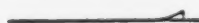
Derail (Switch pt.)



Bumping post



Friction car stop



Double slip sw.



Single slip sw.



Crossing



Bumping post



Single car retarder



Double car retarder



Single car retarder



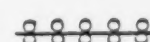
Double car retarder



Electric light



Flood lighting tower



Rail rest



Gantry crane



Mail crane



Boom crane



Track pan



Gas container



Track scale



Stock scale



Rail lubricator



IX. Civil symbols

A. On plan sheets

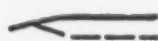
Bridge — general symbol, R.R.		Suspension bridge	
Bridge — general symbol, hwy		Arch bridge	
Drawbridge — R.R.		Pontoon bridge	
Drawbridge — hwy		Ferry	
Footbridge		Ferry	
Truss bridge (W. wood; S. steel; G. girder)		Ford road	
Telephone or telegraph line		Ford trail	
Telephone line		Dam	
Railroad station of any kind		Truss	
Airport		Girder	
Mosque		Const. center line	
Lift bridge		Present ctr. line	
Pier		Profile grade	
Tunnel		Ground line	
		Subcut	
		Ditch grade rt.	
		Ditch grade lt.	

B. On cross section sheets

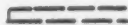
Ground line



Const. cross section



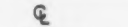
Subcut



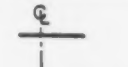
Culvert inp.



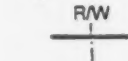
New culvert



Center line



Right of way



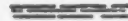
Entrance



Ditch block



Water



Existing pipes or culverts



Proposed pipes or culverts



Dimension line



Existing manhole



Proposed manhole

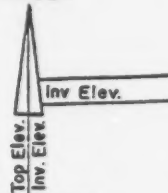


Future manhole



Structure number stationing

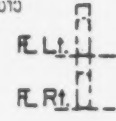
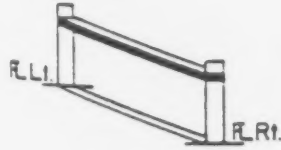
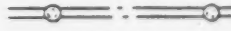
STRUCTURE
NUMBER



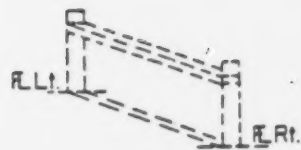
STATIONING

X. Utility and service symbols

NOTE: Give number of wires, owner's name, and address.

Overhead power (cross bar perpendicular to )	 	New 90° box	
Overhead telephone (cross bar parallel to )	 		
Joint ownership poles	 		
Power or telephone overhead (when line crosses )	 	Exist. 90° box	
Power underground	— P-U-G —		
Telephone underground	— T-U-G —		
Power manhole		New 90° pipe	
Telephone manhole			
Oil line	— O — O —		
Water line	— W — W —		
Gas line	— G — G —	Exist. 90° pipe	
Water meter	 W. M.		
Gas meter	 G. M.		
Fire hydrant	 F. H.	New skew box	
Valve			
Water well			
Storm sewer and manhole			
Sanitary sewer	→ S.S. → S.S. → (size and type)		

Exist. skew box



New skew pipe



Exist. skew pipe



Exist. Q_L ground line



Exist. ground line rt.



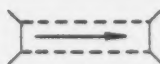
Exist. ground line lt.



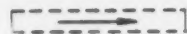
New profile grade line



Arch or flat T masonry culvert



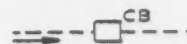
Pipe in excess of 36"



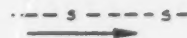
Drain pipe



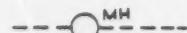
Catch basin



Sewer line



Manhole



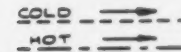
Water tank



Water column



Water pipes



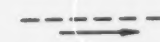
Refrigerant pipe



Gas pipe



Condensate pipe



Steam pipe



Oil pipe



Compressed air pipe



Riser



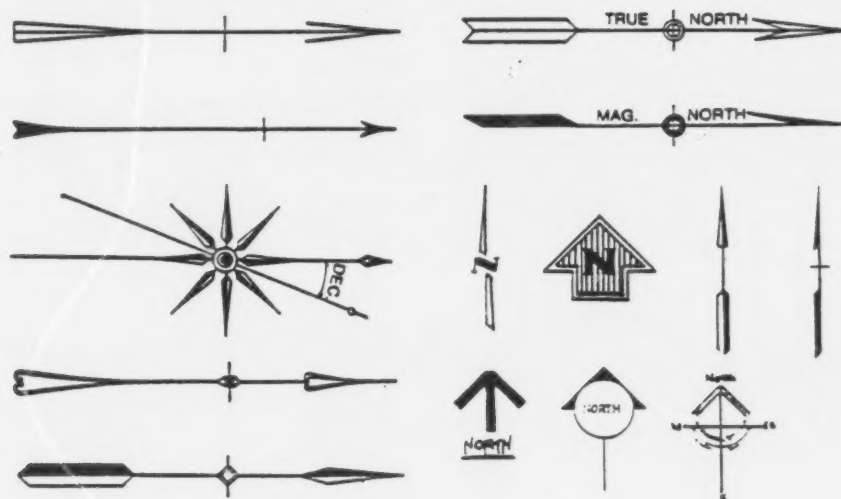
XI. Hydrographic and navigation symbols

Surveyed shore line		4 fathom line	
Unsurveyed shore line		5 fathom line	
Kelp or eel grass		6 fathom line	
Rock underwater		10 fathom line	
Rock awash		20 fathom line	
Breakers along shore		30 fathom line	
Fishing stakes		40 fathom line	
Overfalls and tide rips		50 fathom line	
Limiting danger line		100 fathom line	
Whirlpools and eddies		200 fathom line	
Cable		300 fathom line	
Non-tidal current 3 knots		400 fathom line	
Non-tidal current (special use)		500 fathom line	
Tidal currents flood 2 knots		1000 fathom line	
Tidal currents ebb 1 knot		2000 fathom line	
Tidal currents flood 2nd hour		3000 fathom line	
Tidal currents ebb 3rd hour		Life saving station	
No bottom at 100 fathoms		Coastguard life safety station	
DEPTH CURVERS		Lighthouse	
1 fathom or 6 foot line		Lighthouse (smaller scale)	
2 fathom or 12 foot line		Light vessels	
3 fathom or 18 foot line		Radio station	
		Radio compass station	

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Radio tower	RT	Mooring buoy	
Radio beacon	RBn	Anchorage	
Water gage		Small vessel anchorage	
Lighted beacon		Pond	
General or red buoy		Salt pond	
Not lighted beacon		Intermittent pond	
Black buoy		Salt marsh	
Horizontal striped buoy		Fresh marsh	
Horizontally striped (black & red) buoy		Tidal flat	
Vertically striped buoy			
Checkered buoy			
Perch & ball buoy			
Perch & square buoy			
Whistling buoy			
Bell buoy			
Lighted buoy			

XII. North arrow symbols



XIII. General rules for drawing map symbols

- A. Should be easy to read and understand
- B. Should conform to the general design and purpose of the drawing
- C. Should follow standard and acceptable formats
- D. Should assume as much as possible the form of the actual object it represents
- E. Should never crowd a map

Example: Too many symbols for grass

- F. Number of symbols included on a map is limited by the scale of the map.
- G. Regardless of the scale of the map, symbols are drawn essentially the same size. They must be large enough for reproduction at present and final scale.

NOTE: It is the judgment of the civil drafter and engineer to enlarge or emphasize the symbol according to priority of information shown on the map.

- H. Prominence of a symbol over another is achieved by variation in the line weight of the symbol.

NOTE: The purpose of the map will determine which symbol is made prominent.

- I. Symbols repeated on a map need to be drawn identical to each other.
- J. For all symbols that have a definite base such as grass and marsh, this base should be drawn parallel to the bottom of the sheet. (Never parallel to roadway and streams).

- K. Good rule to follow in proportioning a map would be to draw the important symbols first and work toward the least important features.

XIV. Methods used in drawing symbols

- A. Freehand such as woods, streams, and material symbols
- B. Template for specific mapping symbols
- C. Stick up sheets
- D. Pressure-sensitive transfers
- E. CAD--use of menu symbols to place repetitive symbols

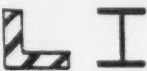
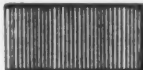
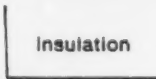
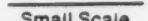
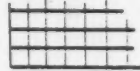
XV. Colors of map symbols

- A. Black--cultural features, boundaries, lettering and notations
- B. Blue--water features such as seas, oceans, lakes, rivers, and canals; dark blue may be used for drainage systems
- C. Brown--contours, sand, washes, and topographic relief
- D. Green--vegetation such as trees, shrubs, orchards, and vineyards
- E. Yellow--additional boundaries and distributional tones
- F. Red--important roads, public land and land grants, subdivisions, and field lines
- G. Gray--shading and hatch marks
- H. Purple--office revisions from aerial photographs

XVI. Common material symbols used in structural and architectural drawings

MATERIAL	PLAN	ELEVATION	SECTION
Earth	None	None	
Plain concrete			Same as plan view
Concrete reinforced with bars			Same as plan view
Concrete reinforced with mesh			Same as plan view
Concrete block			
Gravel Fill	Same as section	None	

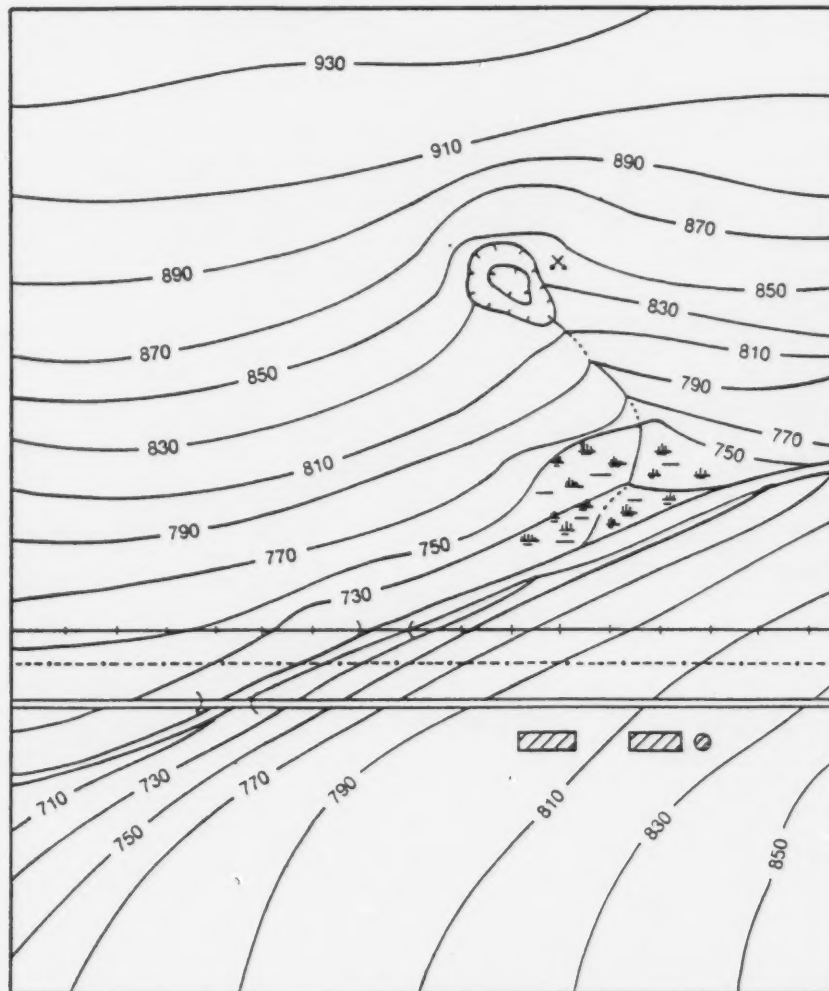
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MATERIAL	PLAN	ELEVATION	SECTION
Wood	Floor areas left blank		
Brick	 Face  Common	 Face or common	Same as plan view
Stone	 Cut  Rubble	 Cut  Rubble	 Cut  Rubble
Structural Steel		Indicate by note	 Specify
Sheet metal Flashing	Indicate by note		 Show Contour
Insulation	Same as section	 Insulation	 Loose fill or batt Board 
Plaster	Same as section	 Plaster	 Stud Lath and plaster
Glass		 	 Large Scale  Small Scale
Tile			

SET UP A MAP LEGEND

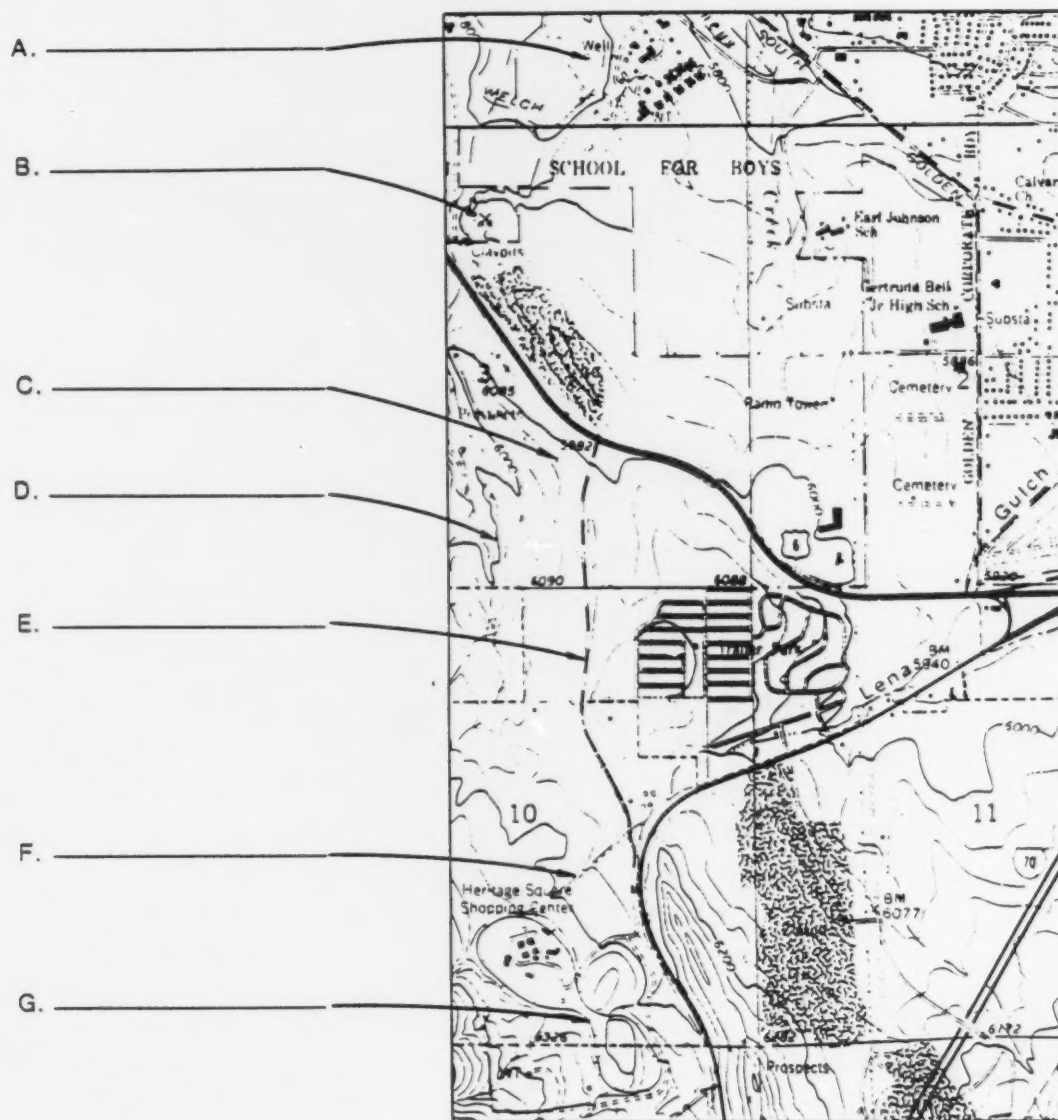
Directions: Using the provided topographic map, find the symbols used to describe features and set up a legend for this map. Ask your instructor for the size of paper and tools to use (pencil or ink).

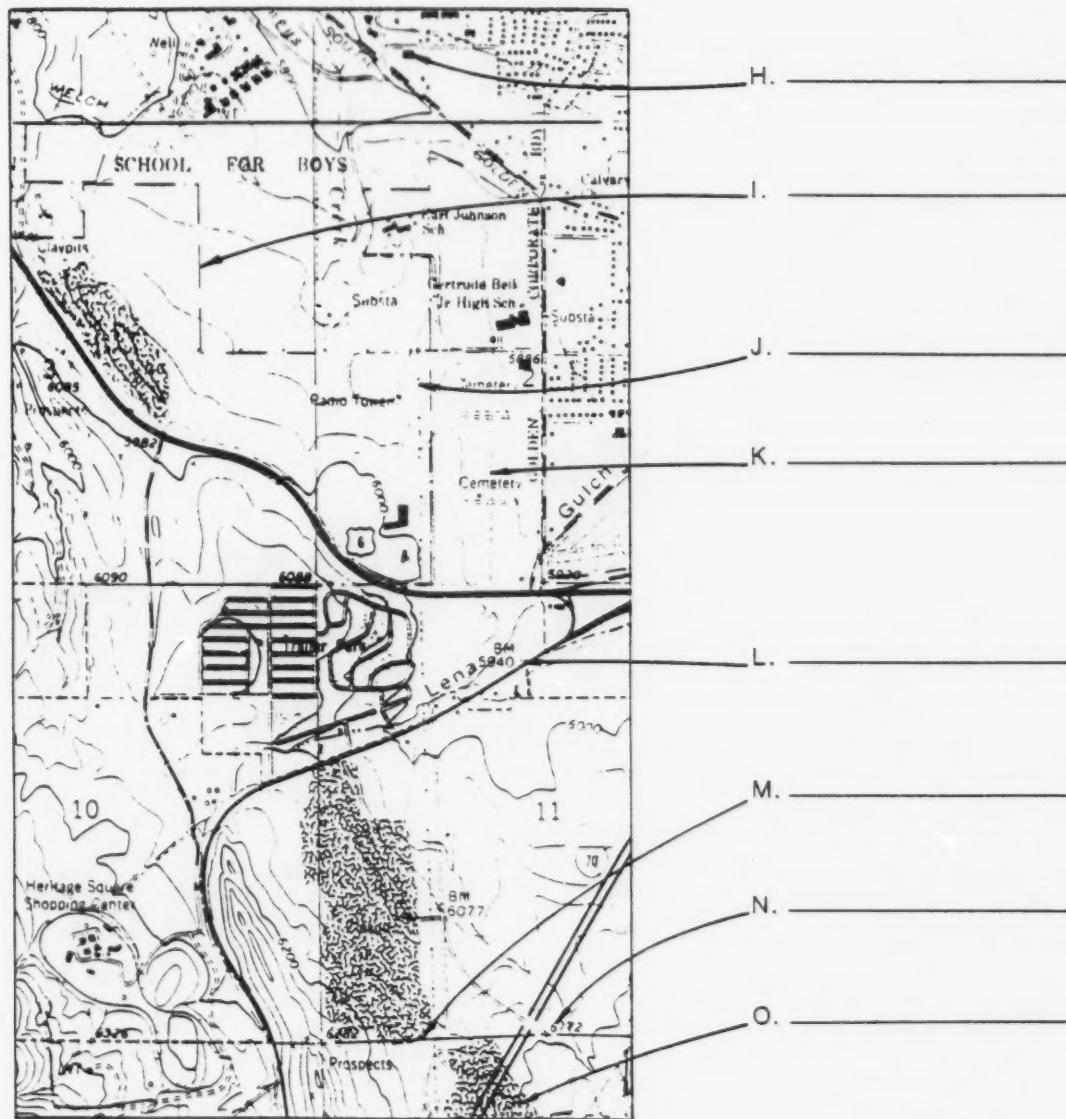
Suggested format: 8 1/2 x 11 film, ink, and Leroy lettering.



LOCATE AND IDENTIFY SYMBOLS AND FEATURES ON A U.S.G.S MAP

Directions: Identify each symbol called for on this portion of U.S.G.S. 7.5-minute quadrangle map. Turn the page for h.-0.

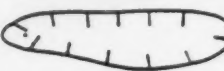




MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS
ANSWERS TO ASSIGNMENT SHEETS

AS 7.1

LEGEND

CONTOUR LINE	
DEPRESSION CONTOUR	
GRAVEL PIT	
MARSH (SWAMP)	
BRIDGE	
RAILROAD	
POWER TRANSMISSION LINE	
BUILDINGS	
WATER TANK	

AS 7.2

A. Well symbol	I. Reservation boundary
B. Clay pit	J. Power transmission line
C. Spot elevation	K. Unimproved road
D. Index contour	L. Bench mark
E. Secondary road	M. Section line
F. Stream	N. Section contour
G. Railroad	O. Gravel
H. Building	

MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS
LESSON 2: TOPOGRAPHIC MAPPING

I. Terms and definitions

- A. **Backsight**--a survey reading taken on a point of known elevation for the purpose of obtaining the height of the instrument; also called a plus(+) sight
- B. **Contour interpolation**--determination of an intermediate value between field values from some known or assumed rate; estimating of contours
- C. **Contour interval**--the vertical distance between the planes of consecutive contour lines, such as 5, 10, 20, 100, or 200
- D. **Contour line**--an imaginary line on the ground connecting all points that are the same elevation above or below sea level
- E. **Datum**--any numerical or geometrical quantity or set of such quantities that serves as a reference or base for other quantities

Example: Mean sea level serves as a datum for elevation
- F. **Depression contour lines**--Indicate an elevation that represents a low place on the ground that has no surface drainage
- G. **Foresight**--a survey reading taken on a new point to determine its elevation; also called a minus (-) sight
- H. **Grade**--an established elevation of the ground or a road surface; the amount of incline or slope from the horizontal expressed usually in percentages
- I. **Gradient**--the rate of grade
- J. **Index contour line**--every 5th contour line, which is numbered
- K. **Intermediate contour lines**--contour lines that are between index contours
- L. **Photogrammetric surveying**--the science of obtaining measurements by means of photographs, usually aerial photographs
- M. **Sea level**--topographic datum line which is the level between high and low tide
- N. **Spot elevation**--a point on a map or chart whose height above a specified reference datum is noted, usually by a dot or small "x" and elevation value
- O. **Stadia**--refers to distance and elevation measurements that have been obtained by surveying methods
- P. **Supplemental contour lines**--represent half intervals between contour lines

- Q. **Topographic map** (as defined by U.S. Geological Survey)--a line and symbol representation of natural and selected man-made features of a part of the earth's surface plotted to a definite scale; distinguishing characteristic is the portrayal of the shape and elevation of the terrain by contour lines

II. Uses of topographic maps

- A. As bases for other maps

Examples: County planning maps, drainage basin maps, geologic maps, land ownership maps, shaded relief maps

- B. Planning highways
C. Selecting airport sites
D. Selecting industrial sites
E. Routing pipelines and power lines
F. Locating boundary lines for cadastral surveys
G. Planning communication facilities
H. Aiding in agricultural research
I. Planning recreation areas
J. Assessing and managing natural resources

III. Types of surveys used in topographic mapping

- A. **Aerial (photogrammetric)**--used for mapping projects covering large areas more than 40 acres
B. **Ground (field) survey**--used for large scale maps of small areas less than 5 acres

NOTE: Often both methods are used in combination. When photogrammetry is used, ground control and field checks are done by a ground survey.

IV. Steps in laying out a topographic survey

- A. Run an accurate closed traverse within the area to be mapped.

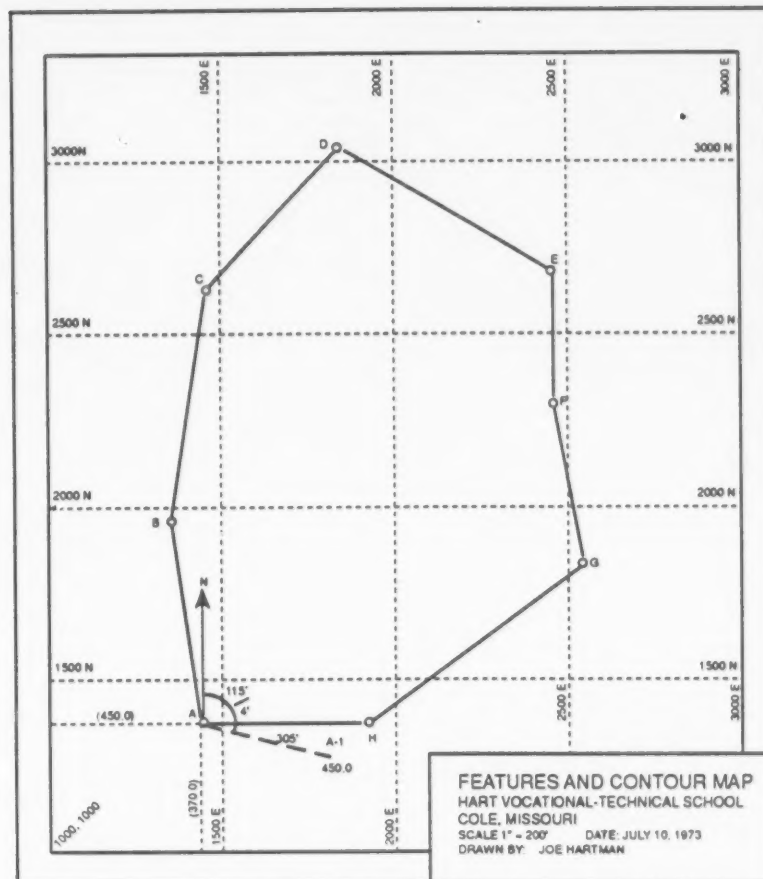
NOTE: Even when an open traverse is run, a closure check is done by connecting the two end stations.

- B. Calculate latitudes and departures, adjust traverse, and calculate coordinates.
C. Using the coordinates, plot the traverse.

NOTE: This establishes horizontal control.

Example:

Figure 1



- D. From the points located by the horizontal control traverse, make a survey (usually stadia) locating all the details of features to be shown.
- E. Establish contours from vertical control.
- V. Methods used to establish contours
 - A. Random shot method (TM 7.1)
 - 1. Establishes horizontal and vertical control.
 - 2. Locates details by direction and distance from a control point.
 - 3. Usually uses the odolite (transit)--stadia method or EDM.

4. Stadia distance is recorded and vertical angle is read for each point; then horizontal distance and elevation are calculated.
 5. Contours can be drawn by interpolation or estimation connecting all points of equal elevation.
- B. Trace contour method--the points on the ground are the elevation of the desired contour established by random shot method. Lines on the map are drawn connecting points of the same elevation.
 - C. Grid method (TM 7.2)--the map is divided into a system of squares or rectangles. The elevations at the corners and critical points on the lines are located. The grid and elevations are plotted and the contours are then drawn by interpolation.
 - D. Cross profile method (TM 7.3)--lines are run out at right angles to the traverse line. Contour points or elevations at changes in slope are established on these lines with their distances out from the traverse. Points are then plotted and points of equal elevation are joined by contour lines. This method is used for development of cross sections for transportation plans.

VI. Selection of contour intervals

- A. Standard of accuracy required affects the selection of a contour interval.

Example: National standards can interpolate a map within 1/2 contour interval. If accuracy required is 1 foot, then a 2-foot maximum interval is necessary.

- B. Terrain type regulates the contour interval.
 1. Rugged terrain requires a larger contour interval.
 2. Flat ground uses a small contour interval to show the surface adequately.
- C. If map scale is reduced, the contour interval is increased.
- D. 5, 10, 20, 100, and 200 feet are the intervals most commonly used.
- E. U.S.G.S. commonly uses 40 foot contour intervals.
- F. Defense Mapping Service (DMS) commonly uses 50 foot contour intervals.
- G. Contour interval should not vary on any one map.

NOTE: Some maps that represent very flat terrain may employ 1/2 contours. These are usually shown as dashed.

- H. Common rule on contour intervals is not to show more than 10 contours per linear inch.

VII. Characteristics of contour lines

- A. A contour is a line, all points of which lie at equal elevations.
- B. Every contour closes upon itself either within or without the limits of the map; in the latter case, it is drawn to the edge of a map.

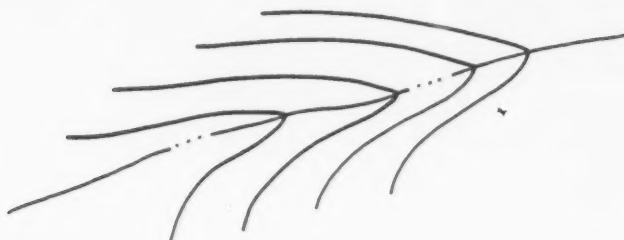
- C. A contour line closing within the limits of the map either indicates a summit or a depression. If the depression does not enclose a body of water, it should be numbered or hachured to indicate its elevation.
- D. Contours never cross each other, except in the case of an overhanging cliff or a cave, and then they must cross twice. Such cases seldom occur, but if they do, the lower contour should be dotted.
- E. On uniform slopes, contours are evenly spaced.
- F. On a plane surface, contours are straight lines, parallel to each other.
- G. The distance between contours varies inversely as the slope.
- H. The sharpest bends in contours occur at their intersection with ridge and valley lines, which they cross at right angles.
- I. A single contour cannot intervene between two other contours having the same elevation either on a summit or in a valley.

Example: The maximum ridge and minimum valley contours must occur in pairs if they do not close within the limits of the map.
- J. One contour cannot be superimposed upon another except where they indicate a vertical cliff.
- K. Contours bend toward the upgrade when crossing a valley or depression, and toward the downgrade when crossing a ridge line.
- L. Contours crossing a railroad laid to an even grade will be spaced at equal intervals.
- M. Contour lines crossing a stream point upstream and form V's; they point down the ridge and form U's when crossing a ridge crest.
- N. Contour lines cannot run into the shore of a lake or other still body of water since the water surface is at the same level at all points.
- O. It is customary to make every fifth contour line (index contour) heavier than the rest. The line is broken at some convenient place and the number representing the elevation is inserted. When contour lines are far apart, each one may be numbered.
- P. On a summit or low point the last contour line is labeled and the elevation within the contour is given.

VIII. Typical contour line configurations

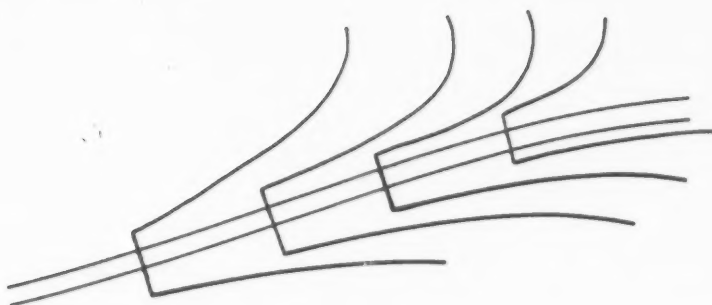
A. Stream

Figure 2



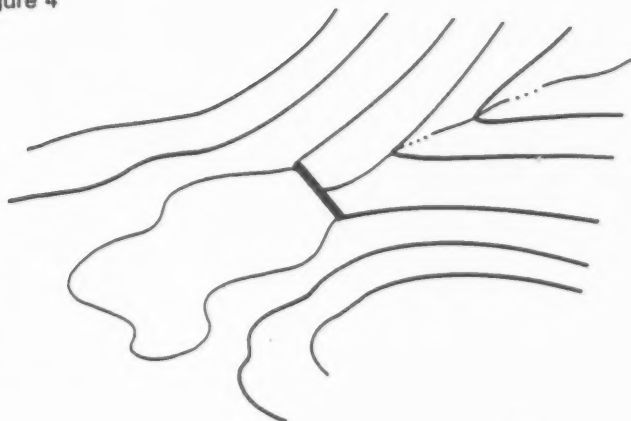
B. Embankment

Figure 3



C. Dam

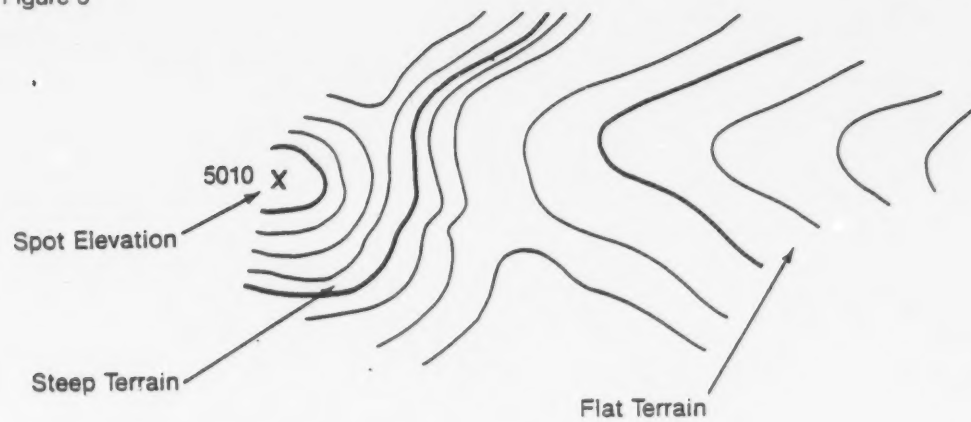
Figure 4



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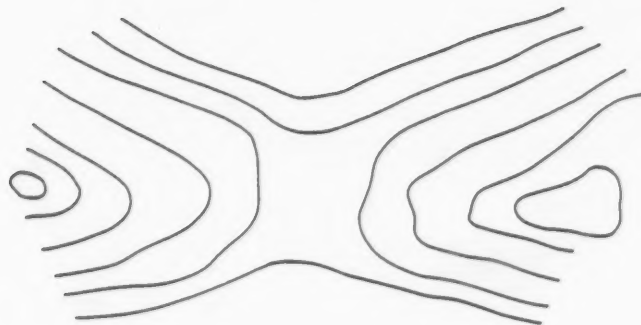
D. Steep and flat terrain

Figure 5



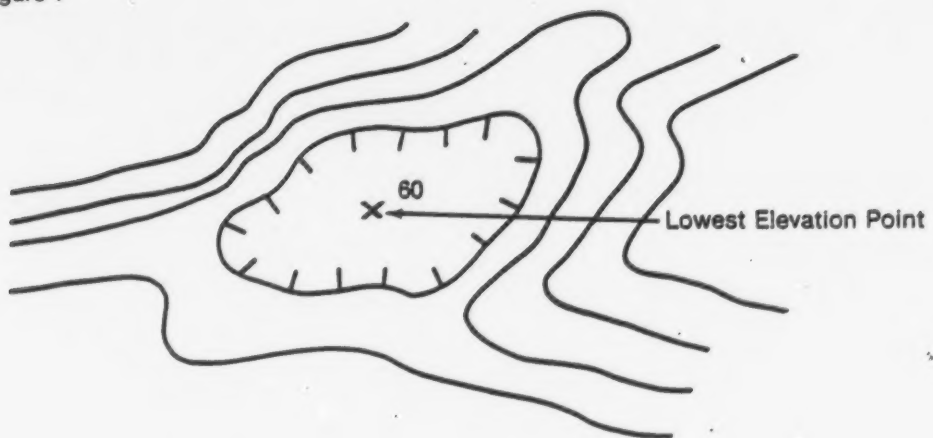
E. Saddle

Figure 6



F. Depression contour

Figure 7



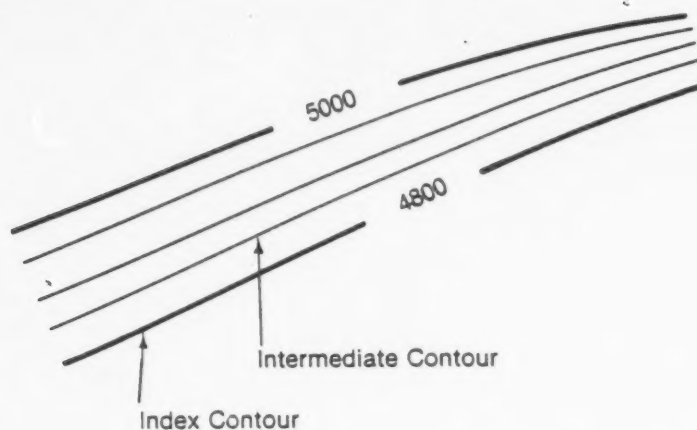
G. Overhang or cliff

Figure 8



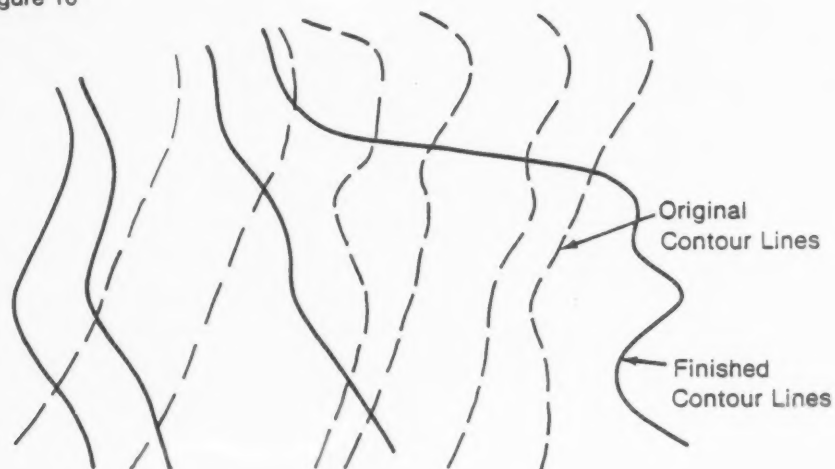
H. Index and intermediate contours

Figure-9



I. Original and finished contours

Figure 10



IX. Developing a profile from a contour map

NOTE: This is the least common method of plotting profile. The preferred method is from profile field notes.

- A. Contour map is placed above the profile grid and is then considered the plan view.
- B. The location of the cross section cutting plane line is marked on the contour drawing.

- C. The extremes of elevations are determined from the cutting plane line on the contour map. (Figure 11)
- D. Appropriate vertical scale is selected and is labeled on the profile paper with the elevation required.

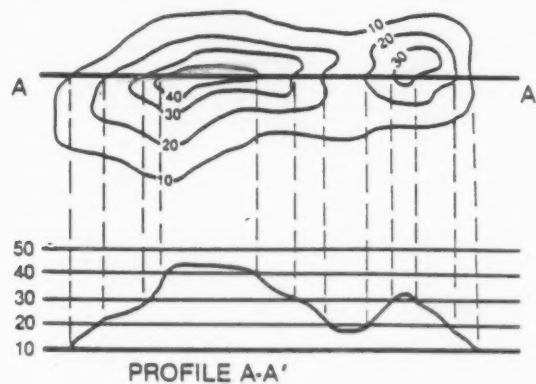
NOTE: It is customary in civil engineering to draw the profile to an exaggerated vertical scale. Horizontal scale is already determined by the contour drawing.

- E. The point of intersection of the cutting plane line and the contour line is projected to the profile.

NOTE: The elevation of the intersecting contour should correspond to the same profile elevation.

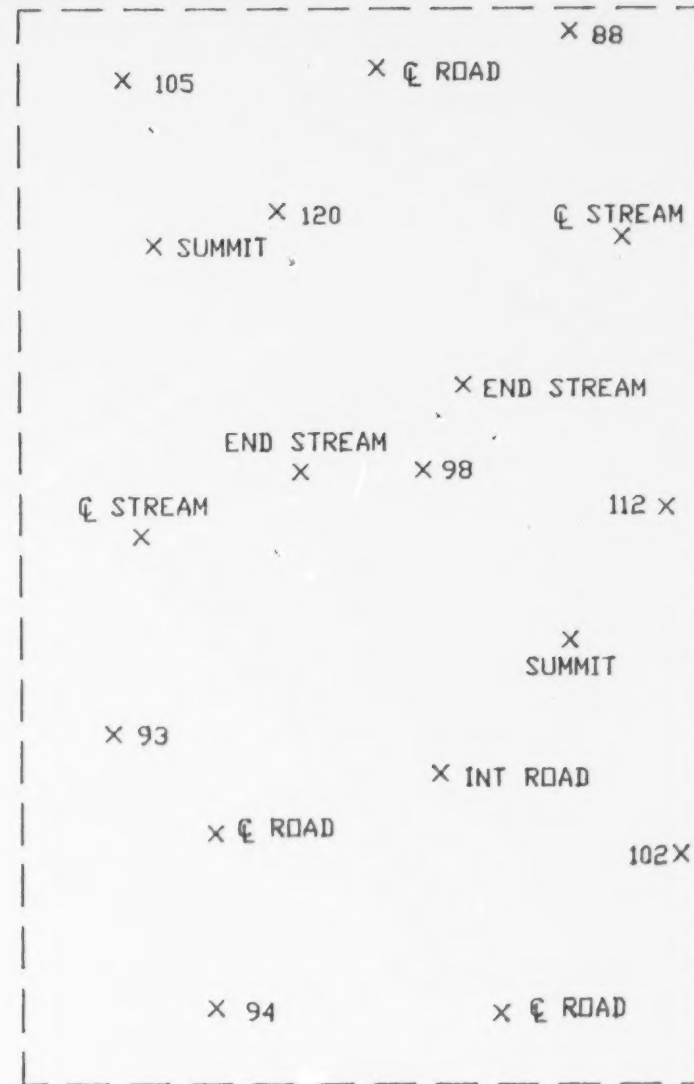
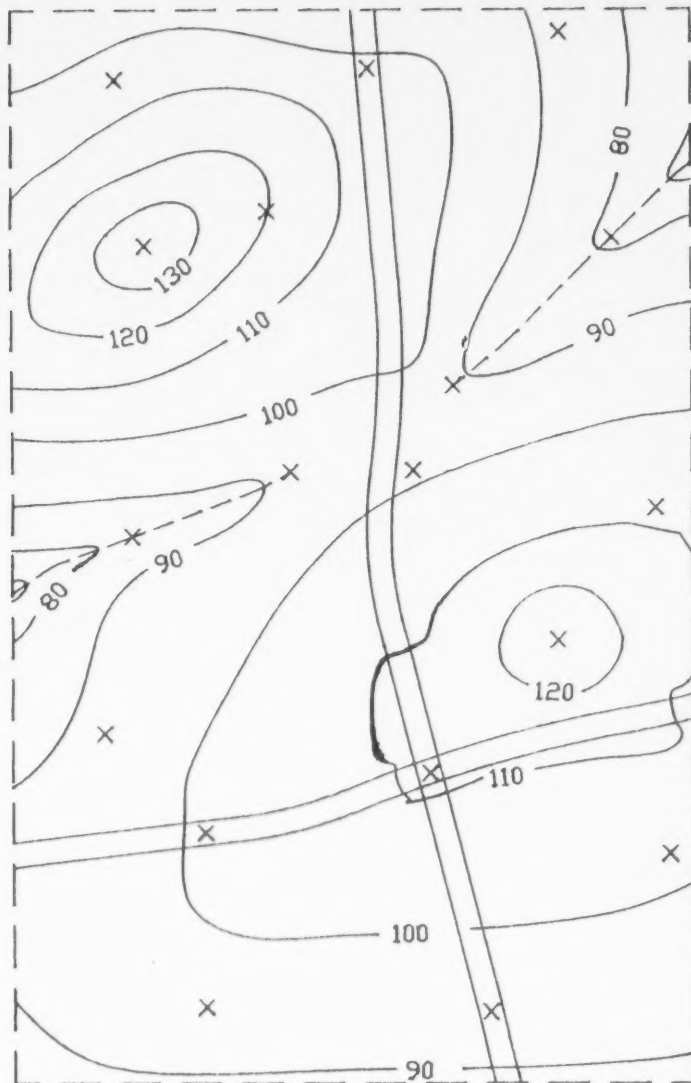
- F. The projected points are connected with a smooth, continuous line and any elevations or features are labeled.

Figure 11

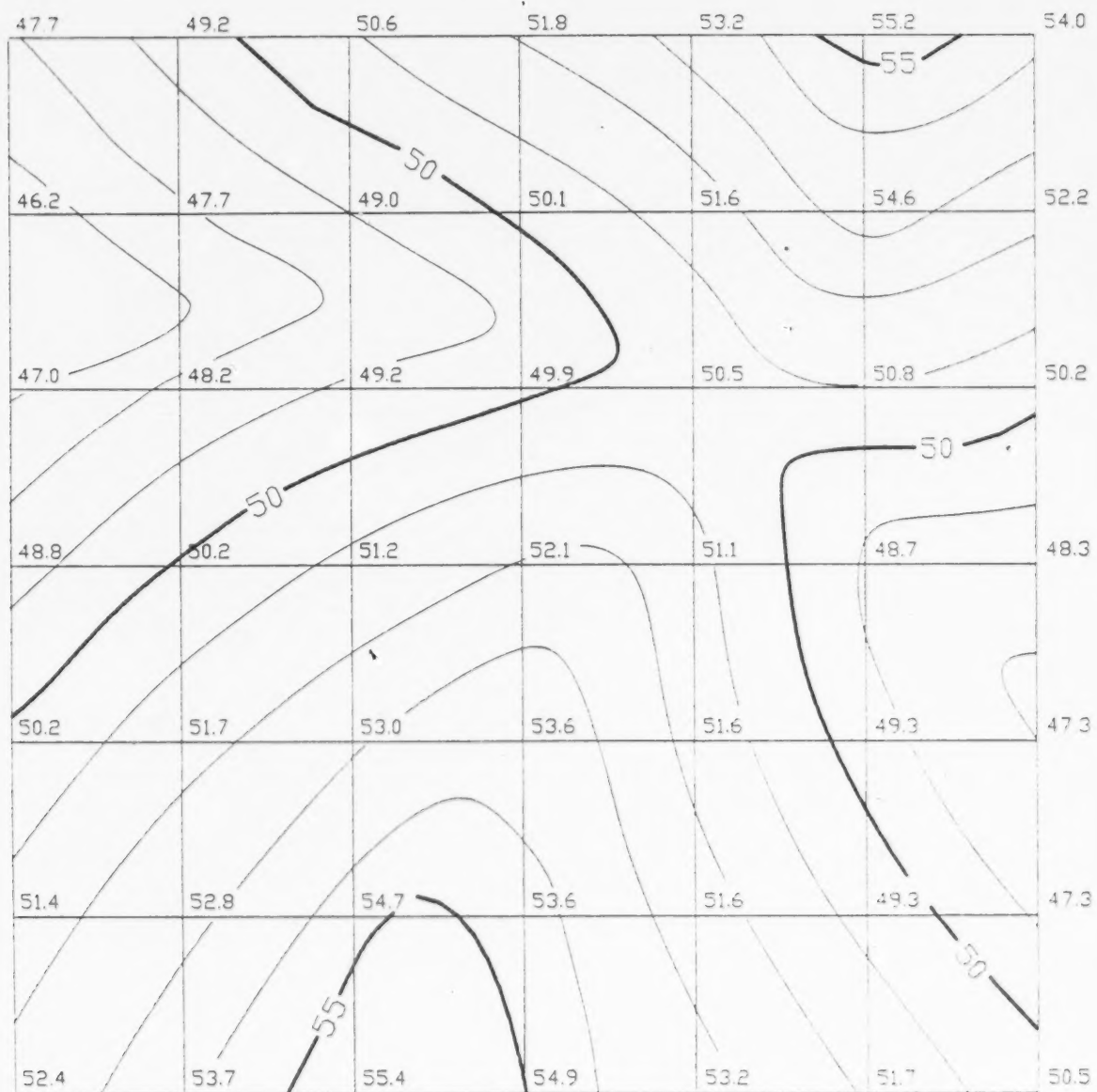


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RANDOM SHOT METHOD FOR ESTABLISHING CONTOURS



GRID METHOD FOR ESTABLISHING CONTOURS



CROSS PROFILE METHOD FOR ESTABLISHING CONTOURS

Station	Elevation
109	956.8
108	950.7
107	938.4
106	948.6
105	958.7

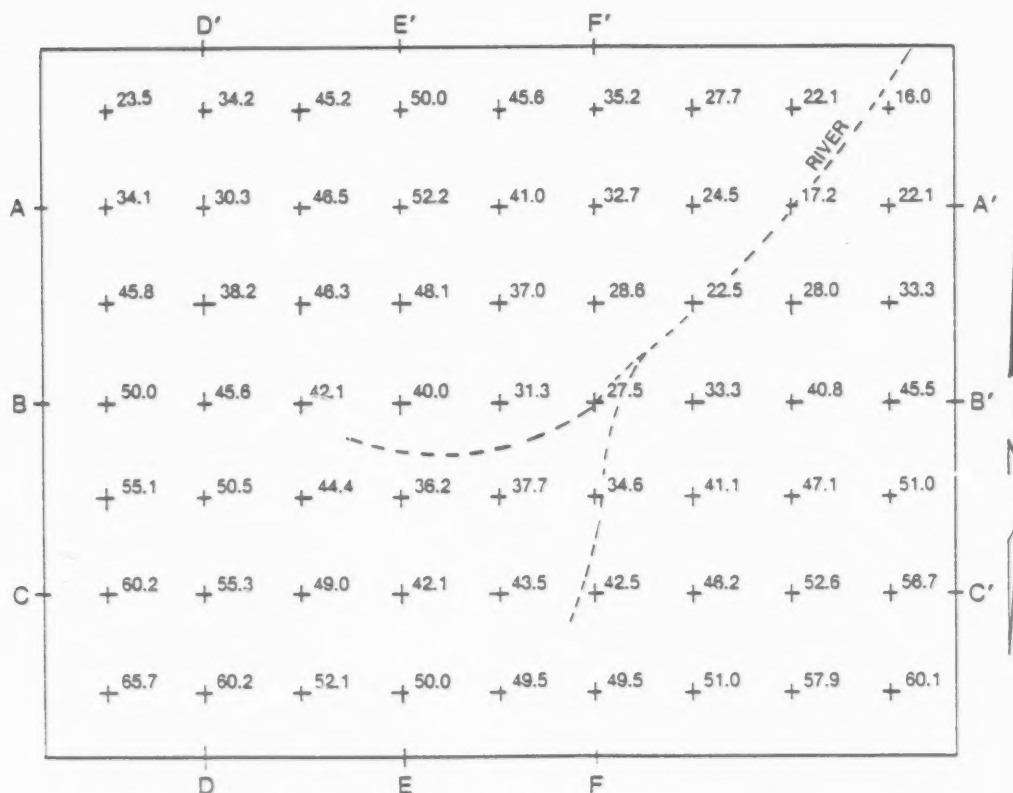
36.7

TM 7.3

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INTERPOLATE CONTOURS FROM A GRID SURVEY AND PREPARE PROFILES FROM THE CONTOUR MAP

PART I--Interpolate contours from a grid survey.



Given: Elevations plotted on a grid for a contour map. Horizontal scale: 1 in. = 20 ft.

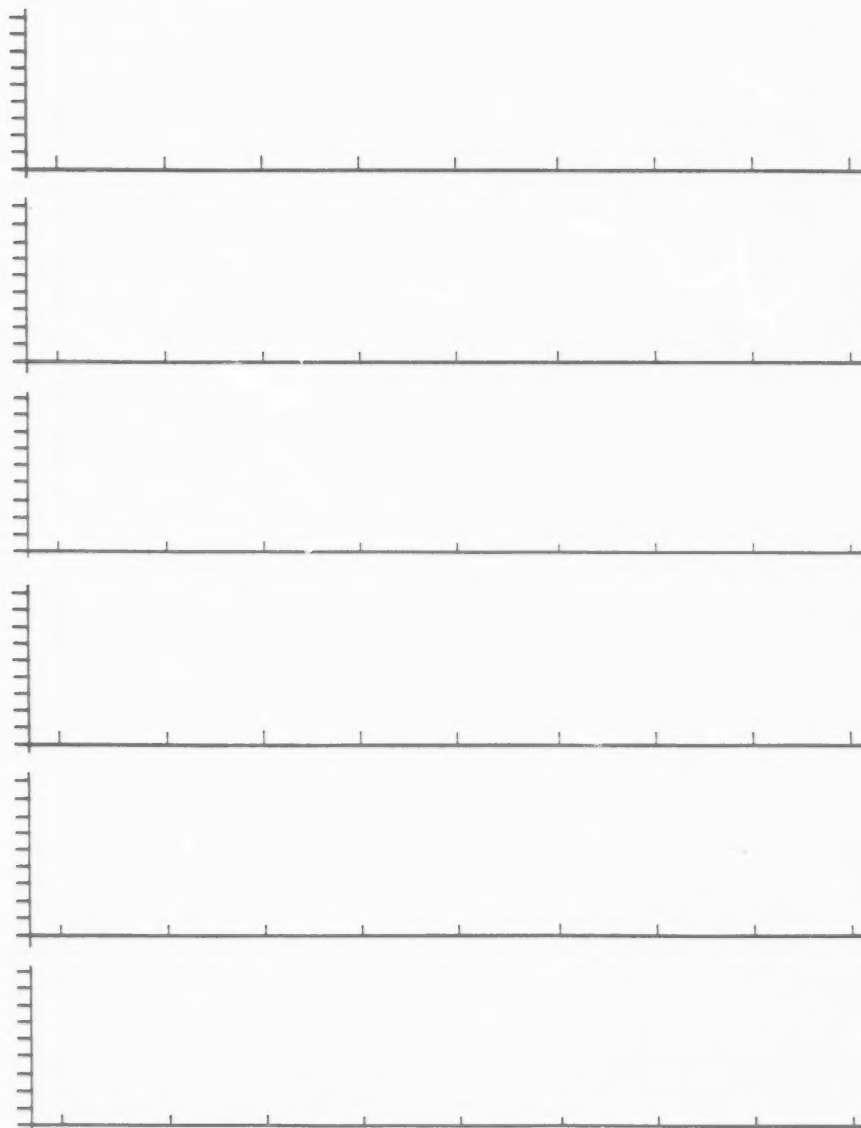
Complete the contour map above.

Use contour interval (CI) = 5 ft.

Label all contours.

PART II--Plot the profiles that are indicated on the contour map in Part I. Plot A-A' through F-F'.

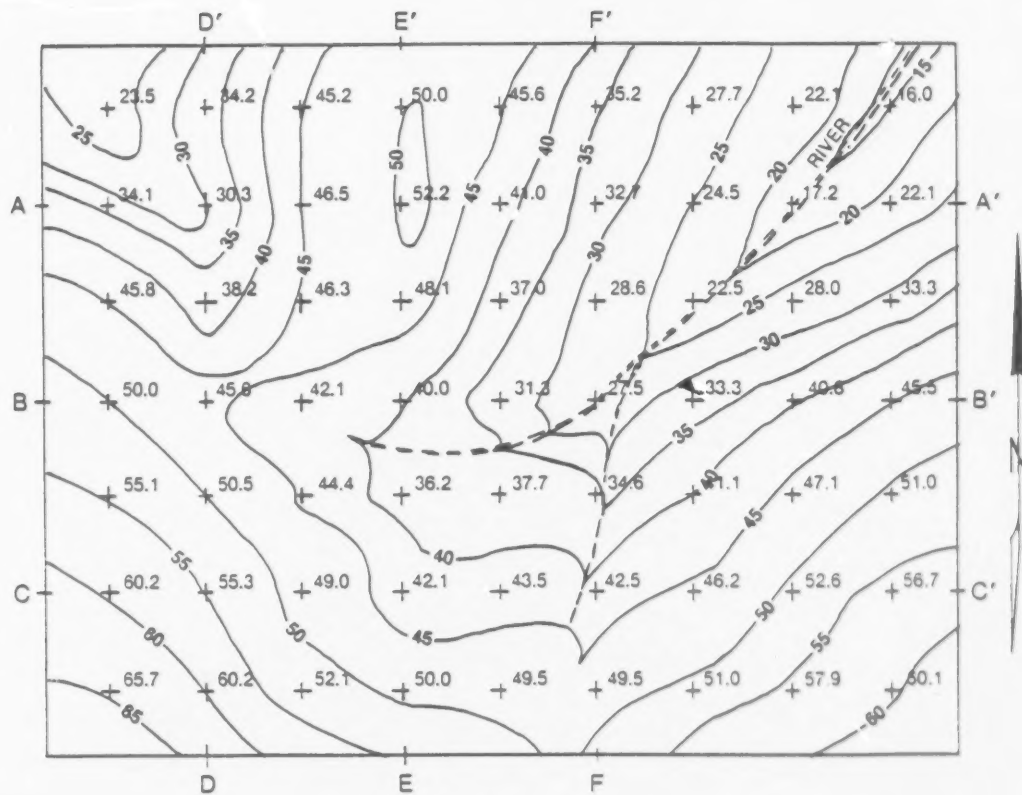
Use horizontal scale: 1 in. = 20 ft, vertical scale: each given mark = 5 ft. Label sections and elevations.



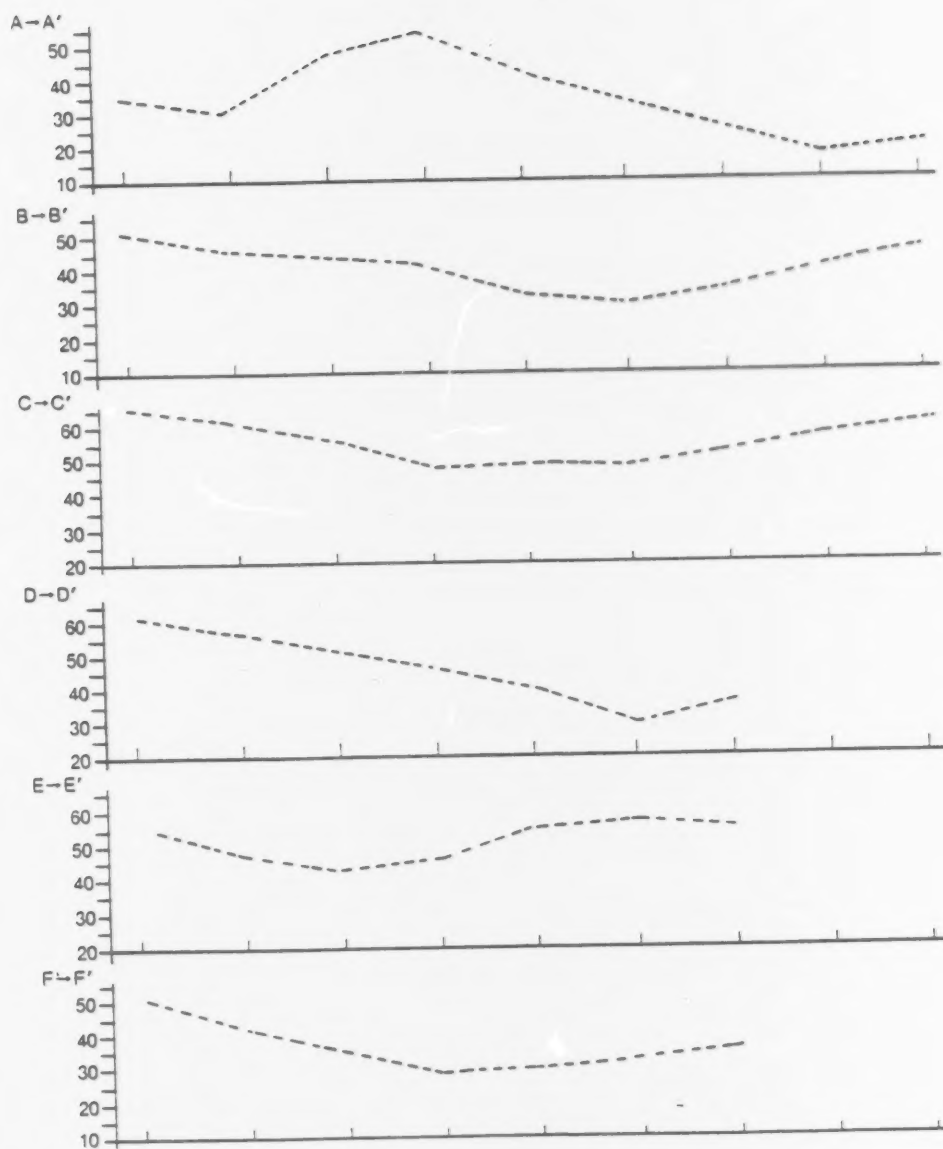
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MODULE: INTRODUCTION TO DRAFTING FIELDS
UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS
LESSON 2: TOPOGRAPHIC MAPPING
ANSWERS TO ASSIGNMENT SHEET

PART I



PART II



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MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS

LESSON 3: PLATS

I. Terms and definitions

- A. **Bench mark**--a relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known
- B. **Cadastral survey**--a survey which creates, marks, defines, retraces, or reestablishes the boundaries and subdivisions of the land
- C. **Corner**--a point on the surface of the earth, determined by the surveying process, which defines an extremity on a boundary of public lands
- D. **Corner description**--the specific data (both old and new) about a corner monument and its accessories, which include marks, positions, and physical characteristics
- E. **Datum line**--in ordinary survey usage, a defined reference line for survey measurement
- F. **Easement**--an interest or right in land owned by another that entitles its holder to a specific limited use, such as laying a sewer, crossing over property, or putting up power lines
- G. **Legal description**--a written statement recognized by law as to the definite location of a tract of land by reference to a survey, recorded map, or adjoining property
- H. **Monument**--a physical structure, such as an iron post, marked stone, or tree in place, which marks the location of a corner point established by a cadastral survey
- I. **Plat, subdivision**--a map of a subdivision of land usually prepared in accordance with state plat statutes or local subdivision regulations or both
- J. **Plat, use**--the component of the new status records, a copy of the master title plat which shows in addition to survey, ownership, and restrictive data, leases, licenses, and permits currently effective
- K. **Platting**--the process of preparing a plat of subdivision according to state and local ordinances
- L. **Plot**--to place survey data upon a map or plat

NOTE: In the past, no clearly defined difference existed between plat and plot. It is recommended to use plat for graphic representation of the survey and plot for the cartographic operations involved in the construction of a map or plat.

II. Characteristic of legal descriptions (TM 7.4 and TM 7.5)

- A. Are written descriptions describing the relationship of a parcel of land to the surrounding surveys
- B. A complete description will begin with the smallest division and progress to the largest.

- C. A complete description can include all three types of land descriptions:
 - 1. Public land sectional system to identify the point of beginning
 - 2. Metes and bounds to describe the boundary lines
 - 3. Lot and block description can be used as an alternate description.

III. Guidelines for drafting a plat

- A. A datum line must be established and elevations shown (these elevations are taken from a benchmark)
- B. Use symbols to represent lakes, ponds, rivers, etc.
- C. Indicate the compass orientation of the lot
- D. Show lot corners by small circles
- E. Show property lines
- F. Show corner elevations above the datum
- G. Show changes in contours by dashed or dotted lines
- H. Show new grade (N.G.) and final grade (F.G)
- I. Show dimensions from property lines to utility lines
- J. Show any easements (these may be determined by building codes)
- K. Show all encroachments to the property
- L. Indicate owner and legal description
- M. Show lot number and addition where it is located
- N. Label utility lines
- O. Show scale

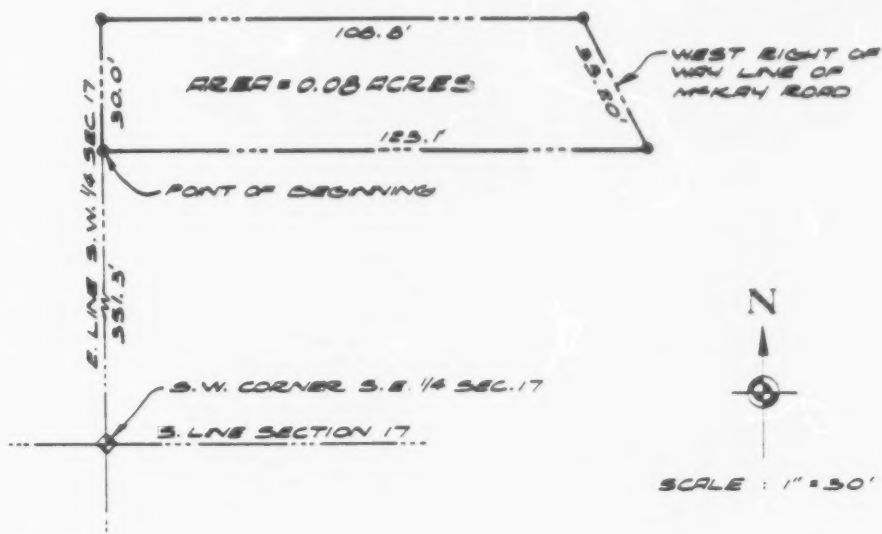
NOTE: Usually a civil engineer's scale is used.

IV. Three methods for laying out and developing a map

- A. Plotting the boundary from the legal description
- B. Plotting by coordinates
- C. Plotting by latitudes and departures

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EXAMPLE OF A LEGAL DESCRIPTION



LEGAL DESCRIPTION:

That part of the Southwest one-quarter of the Southeast one-quarter of Section 17, Township 2 South, Range 67 West of the 6th P.M., County of Adams, State of Colorado, more particularly described as follows:

Commencing at the Southwest corner of the Southeast one-quarter of said Section 17, thence North a distance of 351.3 feet along the East line of the Southwest one-quarter of Section 17, to the point of true beginning; Thence East 123.1 feet more or less, along a line parallel to the South line of Section 17, to the county road; Thence Northwesternly along the right-of-way line of the county road a distance of 33.2 feet more or less; Thence West a distance of 108.8 feet more or less, along a line parallel to the South line of Section 17, to the county road; Thence South a distance of 30.0 feet to the point of beginning, containing 0.08 acres, more or less.

PROPOSED CONSTRUCTION EASEMENT for SOUTH ADAMS COUNTY WASTEWATER TREATMENT PLANT



CONSULTING
ENGINEERS

SELLARDS & GRIGG, Inc.

LAKEWOOD, COLORADO

PROJECT 77016-41

JUNE, 1978

D.P.L.

TYPES OF LAND DESCRIPTIONS USED IN A LEGAL DESCRIPTION

Public Land Sectional Description

All that part of the Northeast Quarter of the Northeast Quarter of Section 12, Township 5 North, Range 2 East of the Fifth Principal Meridian, Clarion Township, Walker County, and State of Missouri, described as follows:

Commencing at the Northeast Corner of said Section 12;
 Thence on an assumed bearing of South $89^{\circ}58'40''$ West on and along the north line of Section 12 a distance of 825.00 feet to the point of beginning;
 Thence South $0^{\circ}02'20''$ West a distance of 721.78 feet;
 Thence South $89^{\circ}58'40''$ West a distance of 320.22 feet;
 Thence North $31^{\circ}18'20''$ West a distance of 844.57 feet to the said north line of Section 12;
 Thence North $89^{\circ}58'40''$ East a distance of 759.55 feet on and along the said north line of Section 12 to the point of beginning.

ALSO known as Lot 5, Block 4, Oak Hills Subdivision, Walker County, Missouri.

Lot and Block Description

Metes and Bounds Description

LAY OUT A BOUNDARY SURVEY FROM A LEGAL DESCRIPTION

Directions: You will be given a written legal description from which you will lay out the boundary survey. Study the following example prior to beginning your assigned problem.

Example:

Facts: The southwesterly line of this Lot 15 is 235.00 feet (77.10m) long and is also on the northeasterly line of Wood Street and bears S 68° 00' E. The northwesterly line of this lot is 184.00 feet (60.37m) long and bears N 35° 00' E. The southeasterly line of the lot is 216.00 feet (70.87m) long and bears S 20° 00' W. The lot will draft onto a letterhead size sheet using a 1" = 30' scale.

Description:

That portion of Lot 15 of Fred Macrae's Tract in Calcasieu Parish, Louisiana, as per map filed in the office of Public Records described by the following courses:

- 1 — Beginning at a point on the northeast line of Wood Street S 68° 00' E 22.40 feet (7.35m) from the most westerly corner of said Lot,
- 2 — N 63° 20' E 38.50 feet (12.63m),
- 3 — N 24° 30' E 47.42 feet (15.56m),
- 4 — S 87° 25' E 87.86 feet (28.83m),
- 5 — N 19° 20' E 35.64 feet (11.69m),
- 6 — S 68° 00' E 78.83 feet (25.86m),
- 7 — S 24° 00' W 141.15 feet (46.31m) to Wood Street,
- 8 — N 68° 00' W 182.62 feet (59.91m) along Wood Street to the point of beginning.

* * *

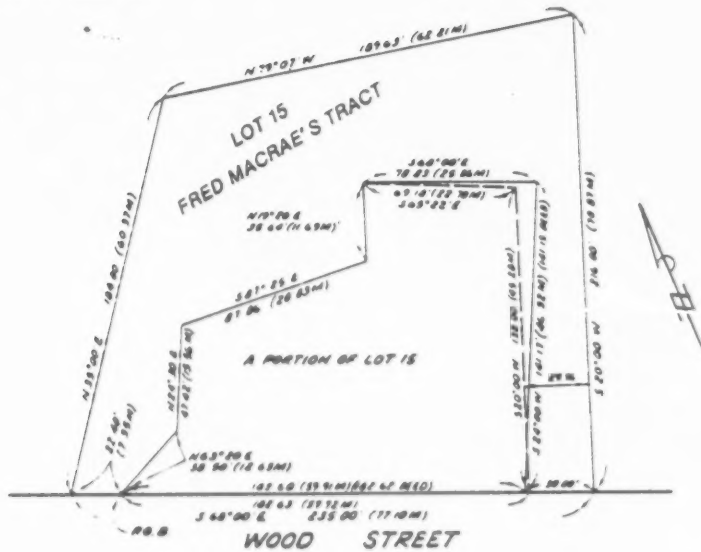
When a course ties to a point, a line or a monument, etc., that then is the controlling factor and if the tie is to a line only, then the distance must be given, while if the tie is to a point, then both the distance and bearing of the line preceding it must be given to the position of that point.

If courses 6 and 7 were changed to read:

- 6 — S 68° 00' E 78.83 feet (25.86m) to a point on a line parallel with and 29.96 feet (9.83m) northwesterly from the southeasterly line of said Lot which point is N 20° 00' E 138.00 feet (45.28m) from the northeasterly line of Wood Street,
 - 7 — S 20° 00' W 138.00 feet (45.28m) to Wood Street,
- draw the additional lines necessary to show their positions with heavy dash lines.

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Drafted layout of example:



Directions: Take the following description and draw a map of the "Adams Property."

1. Lay out on "D" size vellum.
2. Scale: 1" = 30'.
3. Finalize with ink on polyester film.
4. Hand letter dimensions and notes.
5. Use mechanical or transfer lettering for the title information.
6. Place north arrow with scale and scale bar.
7. Place 1/2" border all around.

ADAMS PROPERTY

TRACT 1

A tract of land located in the SW $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 21, T1S, R70W of the 6th P.M., County of Denver, State of Colorado, described as follows:

Commencing at the W $\frac{1}{4}$ Corner of said Section 21, from which the Northwest Corner of said Section 21 bears N00°03' 50"W, thence N62°18' 10"E, 526.68 feet to the most Southerly Corner of that tract of land conveyed to Robert W. Adams and Alice C. Adams as described in Warranty Deed recorded on Film 518 as Reception No. 769196 of the records of Denver County, Colorado and the TRUE POINT OF BEGINNING;

Thence N13°18' 50"W, 323.80 feet along the Southwesterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence N31°21' 10"E, 169.74 feet along the Northwesterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence N77°42' 10"E, 148.83 feet along the Northwesterly line of that tract of land as described on said Film 518 as Reception No. 769196;

Thence S13°09' 50"E, 690.46 feet to the Northwesterly right-of-way line of Colorado State Highway No. 398;

Thence S60°50' 10"W, 140.00 feet along the Northwesterly right-of-way line of said Colorado State Highway No. 398 to the most Southerly Corner of that tract of land conveyed to Robert W. Adams and Alice C. Adams as described in Warranty Deed recorded on Film 598 as Reception No. 842097 of the records of Denver County, Colorado;

Thence N13°09' 50"W, 324.43 feet along the Southwesterly line of that tract of land as described on said Film 598 as Reception No. 842097 to the Southeasterly line of that tract of land as described on said Film 518 as Reception No. 769196;

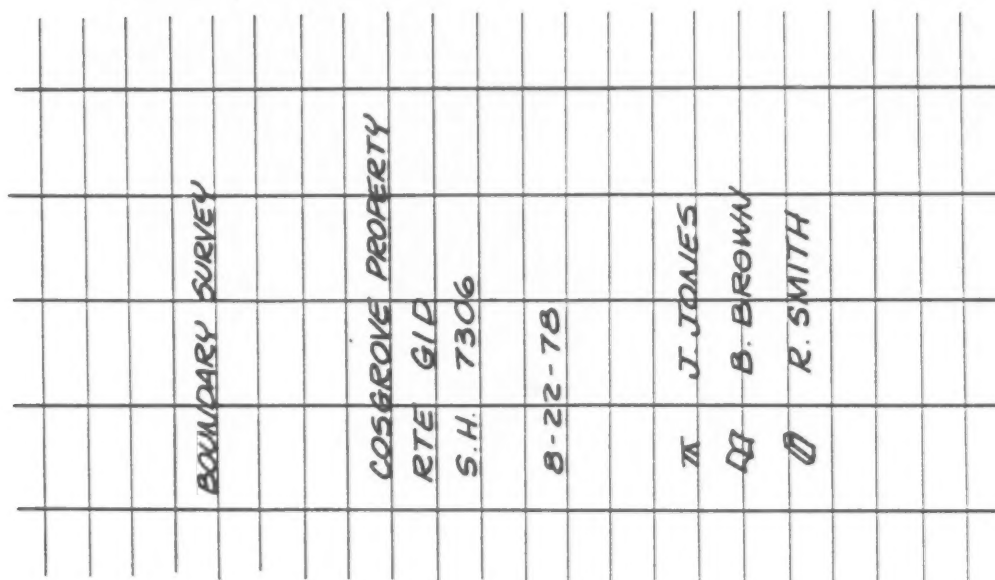
Thence S60°50' 10"W, 137.73 feet along the Southeasterly line of that tract of land as described on said Film 518 as Reception No. 769196 to the TRUE POINT OF BEGINNING.

Area = 3.330 acres, more or less.

REDUCE FIELD NOTES AND PLOT A SIMPLE BOUNDARY SURVEY

Property Traverse

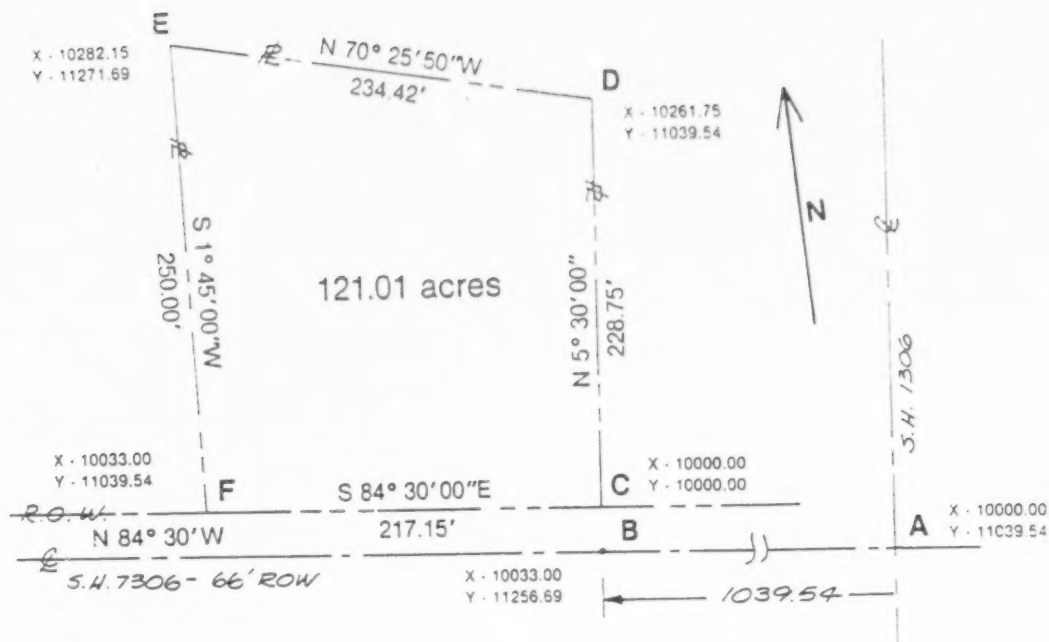
Directions: Given the attached field survey notes, calculate the bearing of each property line, the coordinates for each corner, and the area of the parcel. Assume coordinates of 10,000.00, 10,000.00 for point "A". Check to make sure that the sum of the "x" and "y" coordinates on either side of the parcel are equal. Prepare a working drawing of this parcel on 22" x 34" reproducible paper.



ANSWERS TO ASSIGNMENT SHEETS



AS 7.5



MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS

UNIT TEST

Lesson 1

Match the terms on the right with the correct definitions.

- | | | | |
|---------|--|-----|-----------------------|
| ___ 1. | The structure and composition of the earth's crust | a. | Boundary |
| ___ 2. | Method of charting waters which affords a channel for useful commerce or travel | b. | Cultural features |
| ___ 3. | Man-made features such as railroads, bridges, roads, and public utilities | c. | Geological |
| ___ 4. | A diagram, design, letter, or abbreviation which by convention or reference to a legend is understood to represent a specific characteristic or object | d. | Hydrographic features |
| ___ 5. | A description, explanation, table of symbols, and other information which are printed on a map or chart for better understanding and interpretation | e. | Legend |
| ___ 6. | Showing the details of a map in plan view | ab. | Map scale |
| ___ 7. | A line of demarcation between adjoining parcels of land | ac. | Natural land features |
| ___ 8. | Features on a map such as lakes, streams, terrain, and vegetation | ad. | Navigation |
| ___ 9. | The relationship existing between a distance on a map and the corresponding distance on the earth | ae. | Planimetry |
| ___ 10. | Features along the shore and the submerged parts of bodies of water | bc. | Symbol |

11. List four common types of symbols used in civil drafting.

- a. _____
- b. _____
- c. _____
- d. _____

12. State the correct abbreviations for the following words commonly used in civil drafting.

a. Access	_____	v. Gravel	_____
b. Altitude	_____	w. Highway	_____
c. Approach	_____	x. Joint	_____
d. Area	_____	y. Lateral	_____
e. Average	_____	z. Material	_____
f. Baseline	_____	aa. Meridian	_____
g. Bench mark	_____	bb. National	_____
h. Bridge	_____	cc. North	_____
i. Ceiling	_____	dd. Not to scale	_____
j. Checked	_____	ee. Original	_____
k. Concrete	_____	ff. Pavement	_____
l. Cross road	_____	gg. Plan and profile sheet	_____
m. Curb and gutter	_____	hh. Railroad	_____
n. Diagonal	_____	ii. Reference point	_____
o. East	_____	jj. Right-of-way	_____
p. Elbow	_____	kk. River	_____
q. End to end	_____	ll. Section line	_____
r. Equipment	_____	mm. Shored	_____
s. Expansion joint	_____	nn. Steel	_____
t. External	_____	oo. Survey	_____
u. Foundation	_____	pp. Topography	_____

Select the following true statements concerning factors that determine when an abbreviation should be used by placing an "a" in the appropriate blanks. Place a "b" in blanks of false statements.

13. _____ Use an abbreviation when necessary to save time and space.
14. _____ Use an abbreviation only when the meaning is unquestionably clear to the intended reader.
15. _____ Use your own shortened versions of abbreviations as desired.

State two purposes of symbols on maps.

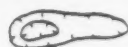
16. _____

17. _____

Identify the following U.S.G.S. topographic map symbols.



18. _____



20. _____



22. _____



24. _____



26. _____



28. _____



30. _____



32. _____



34. _____



19. _____



21. _____



23. _____



25. _____



27. _____



29. _____



31. _____



33. _____



35. _____

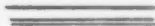
Identify the following other conventional topographic symbols.



36. _____



37. _____



38. _____



39. _____



40. _____

41. _____

Identify the following boundary, fence, and track fixture symbols.



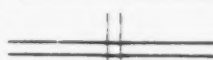
42. _____



43. _____



44. _____



45. _____



46. _____



47. _____

48. _____

49. _____

Match the civil symbols on the right with the correct meanings.

50. _____ Highway bridge (general symbol)

51. _____ Footbridge

52. _____ Steel truss bridge

53. _____ Suspension bridge

54. _____ Arch bridge

55. _____ Pontoon bridge

56. _____ Dam

57. _____ Telephone line

58. _____ Highway drawbridge

59. _____ Pier

a.



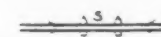
b.



c.



d.



e.



ab.



ac.



ad.



ae.



bc.

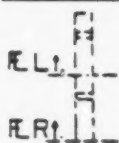


Identify the following utility and service symbols.



○ — W. M.

60. _____



61. _____



62. _____

→ S.S. → S.S.
(size and type)

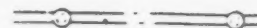
63. _____

64. _____

65. _____

— G — G —

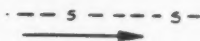
○ — F. H.



66. _____

67. _____

68. _____



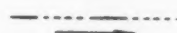
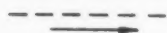
COLD →
HOT →



69. _____

70. _____

71. _____



72. _____

73. _____

74. _____



75. _____

76. _____

Match hydrographic and navigation symbols with the correct meanings.

- 77. ____ Tidal currents flood
- 78. ____ Tidal currents ebb 3rd hour
- 79. ____ Unsurveyed shore line
- 80. ____ Kelp or eel grass
- 81. ____ Life saving station
- 82. ____ General or red buoy
- 83. ____ Whirlpools and eddies
- 84. ____ 1 fathom or 6' line
- 85. ____ 40 fathom line
- 86. ____ Cable

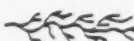
a. 

b. 

c. 

d. 

e.  LSS

ab. 

ac. 

ad. 

ae. 

bc. 

87. ____ Non-tidal current
 88. ____ Surveyed shore line
 89. ____ Lighthouse
 90. ____ Lighted buoy
 91. ____ Lighted beacon
 92. ____ Not lighted beacon
 93. ____ Pond
 94. ____ 4 fathom line
 95. ____ 10 fathom line
 96. ____ 400 fathom line

a. 

b. 

c. 

d. 

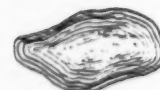
e. 

ab. 

ac. 

ad. 

ae. 

bc 

97. Draw three examples of north arrow symbols in the space below.

Select the following true statements concerning general rules for drawing map symbols by placing an "a" in the appropriate blanks. Place a "b" in appropriate blanks for false statements.

98. ☐ Should be difficult to read so only the engineer can understand.
99. ☐ Should conform to the general design and purpose of the drawing.
100. ☐ Do not follow standard formats.
101. ☐ Should assume as much as possible the form of the actual object it represents.
102. ☐ Should be used excessively, even if they crowd the map.
103. ☐ Number of symbols included on a map is limited by the scale of the map.
104. ☐ On large scale maps, all symbols are drawn much larger.
105. ☐ Prominence of a symbol over another is achieved by variation in the shading and color usage.
106. ☐ Symbols repeated on a map may be drawn differently for variety.
107. ☐ The base of a symbol (such as for grass) should be drawn parallel to the nearest roadway or stream.
108. ☐ Good rule to follow in proportioning a map would be to draw the important symbols first and work toward the least important features.
109. List three methods used in drawing symbols.
- a. _____
- b. _____
- c. _____

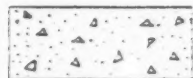
Match color codes on the right with corresponding map symbols.

- | | | | |
|------------|---|-----|--------|
| 110. _____ | Water features | a. | Red |
| 111. _____ | Vegetation | b. | Black |
| 112. _____ | Cultural features, boundaries, lettering and notations | c. | Yellow |
| 113. _____ | Contours, sand, washes, and topographic relief | d. | Blue |
| 114. _____ | Shading and hatch marks | e. | Gray |
| 115. _____ | Office revisions from aerial photographs | ab. | Brown |
| 116. _____ | Additional boundaries and distributional tones | ac. | Purple |
| 117. _____ | Important roads, public land and land grants, subdivisions, and field lines | ad. | Green |

118. Identify the following common material symbols used in structural and architectural drawings.



a. _____



b. _____



c. _____



d. _____



e. _____



f. _____

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Lesson 2

Match the terms on the right with the correct definitions.

- | | | |
|------------|---|------------------------------|
| 119. _____ | An established elevation of the ground or a road surface; the amount of incline or slope from the horizontal expressed usually in percentages | a. Backsight |
| 120. _____ | A survey reading taken on a point of known elevation for the purpose of obtaining the height of the instrument; also called a plus (+) sight | b. Contour interpolation |
| 121. _____ | Any numerical or geometrical quantity or set of such quantities that serves as a reference or base for other quantities | c. Contour interval |
| 122. _____ | The rate of grade | d. Contour line |
| 123. _____ | Indicate an elevation that represents a low place on the ground that has no surface drainage | e. Datum |
| 124. _____ | The vertical distance between the planes of consecutive contour lines, such as 5, 10, 20, 100, or 200 | ab. Depression contour lines |
| 125. _____ | An imaginary line on the ground connecting all points that are the same elevation above or below sea level | ac. Foresight |
| 126. _____ | Determination of an intermediate value between field values from some known or assumed rate; estimating of contours | ad. Grade |
| 127. _____ | A survey reading taken on a new point to determine its elevation; also called a minus (-) sight | ae. Gradient |

128. _____ A point on a map or chart whose height above a specified reference datum is noted, usually by a dot or small "x" and elevation value
129. _____ Contour lines that are between index contours
130. _____ Represent half intervals between contour lines
131. _____ A line and symbol representation of natural and selected man-made features of a part of the earth's surface plotted to a definite scale; distinguishing characteristic is the portrayal of the shape and elevation of the terrain by contour lines
132. _____ Refers to distance and elevation measurements that have been obtained by surveying methods
133. _____ Topographic datum line which is the level between high and low tide
134. _____ Every 5th contour line, which is numbered
135. List five uses of topographic maps.
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

- a. Index contour line
- b. Intermediate contour
- c. Sea level
- d. Spot elevation
- e. Stadia
- ab. Supplemental contour lines
- ac. Topographic map

Match types of surveys used in topographic mapping listed on the right with the size of area to be mapped.

136. _____ Used for large scale maps of small areas less than 5 acres
137. _____ Used for mapping projects covering large areas more than 40 acres
- a. Aerial survey
- b. Ground survey

138. Arrange in order the following steps in laying out a topographic survey by placing the correct sequence numbers (1-5) in the appropriate blanks.

- ___ a. Calculate latitudes and departures, adjust traverse, and calculate coordinates.
- ___ b. From the points located by the horizontal control traverse, make a survey locating all the details of features to be shown.
- ___ c. Run an accurate closed traverse within the area to be mapped.
- ___ d. Establish contours from vertical control.
- ___ e. Using the coordinates, plot the traverse.

Match the methods used to establish contours on the right with the correct descriptions.

- | | | |
|----------|---|-------------------------|
| 139. ___ | Establishes horizontal and vertical control. Locates details by direction and distance from a control point. Stadia distance from a control point. Stadia distance is recorded and vertical angle is read for each point; then horizontal distance and elevation are calculated. Contours can be drawn by interpolation or estimation connecting all points of equal elevation. | a. Cross profile method |
| | | b. Grid method |
| | | c. Random shot method |
| | | d. Trace contour method |
| 140. ___ | The points on the ground are the elevation of the desired contour established by random shot method. Lines on the map are drawn connecting points of the same elevation. | |
| 141. ___ | The map is divided into a system of squares or rectangles. The elevations at the corners and critical points on the lines are located. The grid and elevations are plotted and the contours are then drawn by interpolation. | |
| 142. ___ | Lines are run out at right angles to the traverse line. Contour points or elevations at changes in slope are established on these lines with their distances out from the traverse. Points are then plotted and points of equal elevation are joined by contour lines. This method is used for development of cross sections for transportation plans. | |

Select true statements concerning the selection of contour intervals by placing an "a" next to the true statements. Place a "b" next to the false statements.

- 143. ___ The standard of accuracy required affects the selection of a contour interval.
- 144. ___ Rugged terrain requires a larger contour interval.
- 145. ___ If map scale is reduced, the contour interval is reduced.

146. ____ 10-foot and 100-foot intervals are rarely used.
147. ____ U.S.G.S. commonly uses 5 foot contour intervals.
148. ____ Defense Mapping Service (DMS) commonly uses 50 foot contour intervals.
149. ____ Common rule on contour intervals is not to show more than 1 contour per linear inch.

Complete the following statements concerning characteristics of contour lines by circling the correct words.

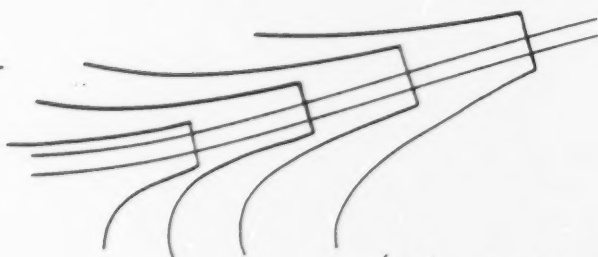
150. A contour is a line, all points of which lie at equal (elevations, distances from a bench mark).
151. Every contour closes upon itself (within, without, within or without) the limits of the map.
152. A contour line closing within the limits of the map either indicates a summit or a (river, depression).
153. Contours never cross each other, except in the case of a/an (mountain, overhanging cliff) or a cave, and then they must cross twice.
154. On uniform slopes, contours are (evenly, unevenly) spaced.
155. The sharpest bends in contours occur at their intersection with ridge and valley lines, which they cross at (45°, right) angles.
156. Contours bend toward the (upgrade, downgrade) when crossing a valley or depression, and toward the (upgrade, downgrade) when crossing a ridge line.
157. Contours crossing a railroad laid to an (even, uneven) grade will be spaced at equal intervals.
158. Contour lines crossing a stream point (upstream, downstream) and form V's.
159. Contour lines (can, cannot) run into the shore of a lake or other still body of water since the water is at the same level at all points.
160. It is customary to make every fifth contour line (**lighter, heavier**) than the rest. The line is broken at some convenient place and the number representing the elevation is inserted. When contour lines are far apart, each one may be numbered.

Match the contour line features on the right with their correct configurations.

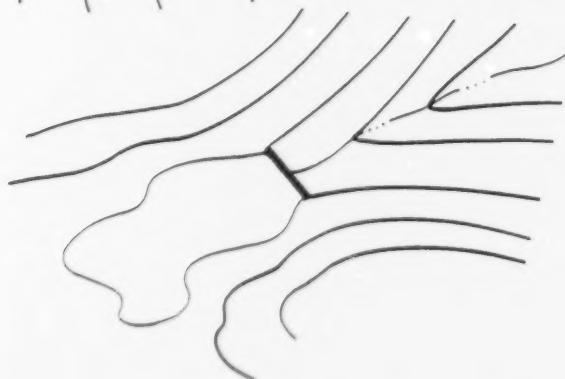
161. _____



162. _____

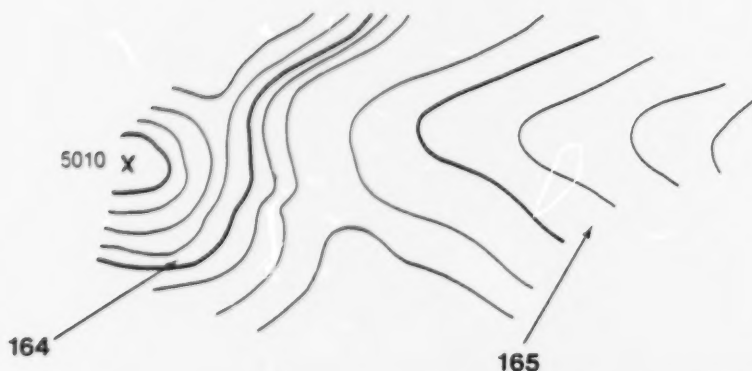


163. _____



164. _____

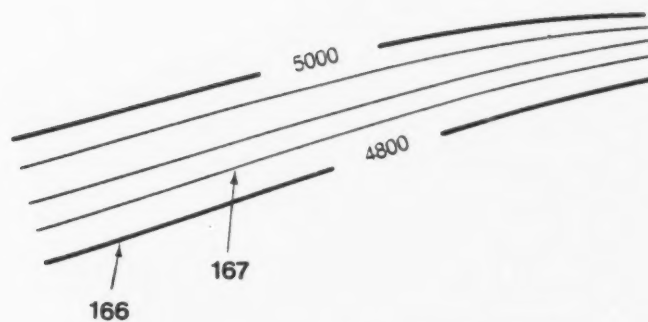
165. _____



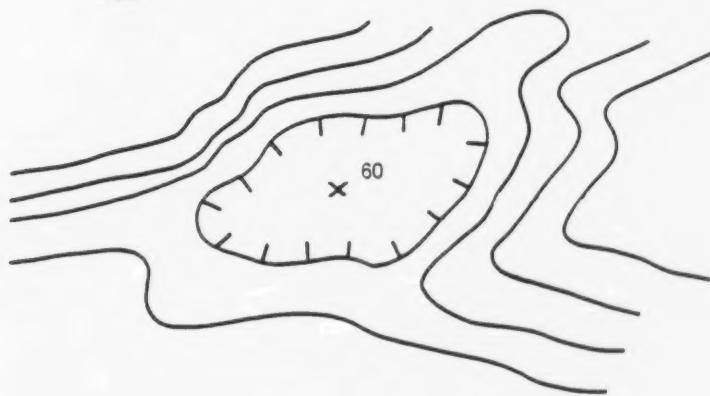
- a. Stream
- b. Embankment
- c. Dam
- d. Steep terrain
- e. Flat terrain
- ab. Saddle
- ac. Depression contour
- ad. Overhang or cliff
- ae. Index contour
- bc. Intermediate contour

166. _____

167. _____



168. _____



169. _____



170. _____

498

171. Arrange in order the steps used to develop a profile from a contour map by placing the correct sequence numbers (1-6) in the appropriate blanks.

- ___ a. The extremes of elevations are determined from the cutting plane line on the contour map.
- ___ b. The projected points are connected with a smooth, continuous line and any elevations or features are labeled.
- ___ c. The location of the cross section cutting plane line is marked on the contour drawing.
- ___ d. Contour map is placed above the profile grid.
- ___ e. The point of intersection of the cutting plane line and the contour line is projected to the profile.
- ___ f. Appropriate vertical scale is selected and is labeled on the profile paper with the elevations required.

Lesson 3

Match terms related to plats and subdivisions with the correct definitions.

- | | | |
|------------|--|-----------------------|
| 172. _____ | An interest or right in land owned by another that entitles its holder to a specific limited use, such as laying a sewer, crossing over property, or putting up power lines | a. Bench mark |
| 173. _____ | A survey which creates, marks, defines, retraces, or reestablishes the boundaries and subdivisions of the land | b. Cadastral survey |
| 174. _____ | A written statement recognized by law as to the definite location of a tract of land by reference to a survey, recorded map, or adjoining property | c. Corner |
| 175. _____ | A point on the surface of the earth, determined by the surveying process, which defines an extremity on a boundary of public lands | d. Corner description |
| 176. _____ | The specific data about a corner monument and its accessories which include marks, positions, and physical characteristics | e. Datum line |
| 177. _____ | In ordinary survey usage, a defined reference line for survey measurement | ab. Easement |
| 178. _____ | To place survey data upon a map or plat | ac. Legal description |
| 179. _____ | A relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known | ad. Monument |
| 180. _____ | The process of preparing a plat or subdivision according to state and local ordinances | ae. Plat, subdivision |
| 181. _____ | The component of the new status records, a copy of the master title plat which shows in addition to survey, ownership, and restrictive data, leases, licenses, and permits currently effective | bc. Plat, use |
| 182. _____ | A physical structure, such as an iron post, marked stone, or tree in place, which marks the location of a corner point established by a cadastral survey | bd. Platting |
| 183. _____ | A map of a subdivision of land usually prepared in accordance with state plat statutes or local subdivision regulations or both | be. Plot |

184. Complete the following statements concerning legal descriptions by circling the correct words.

- a. Are (**written, oral**) descriptions describing the relationship of a parcel of land to the surrounding surveys.
- b. A complete description will begin with the (**smallest, largest**) division and go to the (**smallest, largest**).
- c. A complete description can include all three types of land descriptions:
 - 1) (**Public land sectional system, Metes and bounds**) to identify the point of beginning
 - 2) (**Public land sectional system, Metes and bounds**) to describe the boundary lines
 - 3) Lot and block description can be used as an alternate description.

185. List seven guidelines for drafting a plat.

Example: Show lot corners by small circles

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____

186. List two methods for laying out and developing a map.

- a. _____
- b. _____

MODULE: INTRODUCTION TO DRAFTING FIELDS

UNIT VII: INTRODUCTION TO SURVEYING (CIVIL) DRAWINGS

ANSWERS TO UNIT TEST

Lesson 1 (P-1)

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. c 2. ad 3. b 4. bc 5. e 6. ae 7. a 8. ac 9. ab 10. d 11. Any four of the following: <ol style="list-style-type: none"> a. Map symbols b. Drawing symbols c. Labels in the form of abbreviations d. Pipe symbols e. Weldment symbols f. Utility symbols g. Material symbols h. Oil and gas symbols 12. <ol style="list-style-type: none"> a. ACC b. ALT c. APPR d. A e. AVG f. BL or B_L g. BM h. BR i. CLG j. CKD k. CONC l. X RD m. C&G n. DIAG o. E p. ELL q. E to E r. EQPT s. EXP JT t. EXT u. FDN v. GVL w. HWY x. JT y. LATL | <ol style="list-style-type: none"> z. MTL aa. MER bb. NATL cc. N dd. NTS ee. ORIG ff. PVMT or PAVT gg. P&P Sheet hh. RR ii. RP jj. R/W or ROW kk. R ll. SL or S_L mm. SHO nn. STL oo. SURV pp. TOPO 13. a 14. a 15. b 16. To represent the location and identity of land features that are generally too large to be shown in detail on a map 17. To help keep information on a map to a minimum and thereby avoid cluttering 18. Primary highway, hard surface 19. Single track railroad 20. Depression contours 21. Cut 22. Small falls 23. Fill 24. Intermittent streams 25. Small rapids 26. Marsh (swamp) 27. Tanks: oil, water, etc. (labeled only if water) 28. Church 29. Buildings (barn, warehouse, etc.) 30. National boundary line 31. State boundary line 32. County, parish, or municipal boundary line 33. Road overpass and underpass |
|---|---|

34. Road bridge
35. Power transmission line
36. Fence line
37. Levee
38. Trees
39. Curb and gutter (proposed)
40. School
41. Manhole
42. Track pan
43. Barbed wire fence
44. Stone fence
45. Single car retarder
46. Mail crane
47. Crossing
48. Rail fence
49. Picket fence
50. b
51. ae
52. d
53. c
54. ad
55. ab
56. a
57. e
58. ac
59. bc
60. Overhead power
61. Overhead telephone
62. Water meter
63. Existing 90° pipe
64. New 90° box
65. Sanitary sewer
66. Gas line
67. Fire hydrant
68. Storm sewer and manhole
69. Sewer line
70. Water pipes
71. Compressed air pipe
72. Condensate pipe
73. Oil pipe
74. Refrigerant pipe
75. Water column
76. Catch basin
77. ac
78. ad
79. c
80. ab
81. e
82. d
83. a
84. b
85. bc
86. ae
87. d

88. e
89. ac
90. ad
91. ae
92. b
93. bc
94. c
95. a
96. ab
97. Evaluated to the satisfaction of the instructor
98. b
99. a
100. b
101. a
102. b
103. a
104. b
105. b
106. b
107. b
108. a
109. Three of the following:
 - a. Freehand, such as woods, streams, material symbols
 - b. Template for specific mapping symbols
 - c. Stick up sheets
 - d. Pressure-sensitive transfers
 - e. CAD
110. d
111. ad
112. b
113. ab
114. e
115. ac
116. c
117. a
118.
 - a. Earth
 - b. Plain concrete
 - c. Rubble cut
 - d. Concrete reinforced with bars
 - e. Wood
 - f. Brick (face or common)

400

Lesson 2 (P-2)

- 119. ad
- 120. a
- 121. e
- 122. ae
- 123. ab
- 124. c
- 125. d
- 126. b
- 127. ac
- 128. b
- 129. b
- 130. ab
- 131. ad
- 132. e
- 133. d
- 134. a
- 135. Any five of the following:
 - a. As bases for other maps
 - b. Planning highways
 - c. Selecting airport sites
 - d. Selecting industrial sites
 - e. Routing pipelines and power lines
 - f. Locating boundary lines for cadastral surveys
 - g. Planning communication facilities
 - h. Aiding in agricultural research
 - i. Planning recreation areas
 - j. Assessing and managing natural resources
- 136. b
- 137. a
- 138. 2, 4, 1, 5, 3
- 139. c
- 140. d
- 141. b
- 142. a
- 143. a
- 144. a
- 145. b
- 146. b
- 147. b
- 148. a
- 149. b
- 150. Elevations
- 151. Within or without
- 152. Depression
- 153. Overhanging cliff
- 154. Evenly
- 155. Right
- 156. Upgrade, downgrade
- 157. Even
- 158. Upstream
- 159. Cannot
- 160. Heavier
- 161. ad
- 162. b
- 163. c
- 164. d
- 165. e
- 166. ae
- 167. bc
- 168. ac
- 169. a
- 170. ab
- 171. 3, 6, 2, 1, 5, 4

Lesson 3 (P-3)

- 172. ab
- 173. b
- 174. ac
- 175. c
- 176. d
- 177. e
- 178. be
- 179. a
- 180. bd
- 181. bc
- 182. ad
- 183. ae
- 184. a. Written
- b. Smallest, largest
- c. 1) Public land sectional system
- 2) Metes and bounds
- 185. Any seven of the following:
 - a. A datum line must be established and elevations shown
 - b. Use symbols to represent lakes, ponds, rivers, etc.
 - c. Indicate the compass orientation of the lot
 - d. Show property lines
 - e. Show corner elevations above the datum
 - f. Show changes in contours by dashed or dotted lines
 - g. Show new grade (N.G.) and final grade (F.G.)
 - h. Show dimensions from property lines to utility lines
 - i. Show any easements
 - j. Show all encroachments to the property
 - k. Indicate owner and legal description
 - l. Show lot number and addition where it is located
 - m. Label utility lines
 - n. Show scale
- 186. Any two of the following:
 - a. Plotting the boundary from the legal description
 - b. Plotting by coordinates
 - c. Plotting by latitudes and departures

400